AUSCULTATION AND PERCUSSION.

Teque auscultantem palpantem et percutientem
Pectora, sic morbi ducere signa vident.

R. B. Carminis Elegiaci, vv. 223, 224.

AUSCULTATION AND PERCUSSION:

TOGETHER WITH

THE OTHER METHODS OF PHYSICAL EXAMINATION OF THE CHEST.

BY

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PREFACE.

This new Edition has been thoroughly revised; yet the bulk of the book is increased very little. The Table of Contents will help to show in what way the subject is treated. Utility has been the test applied to the many methods of physical examination. I have written in the belief that methods which are useful could never be discussed too fully; and that those which are remote from use, obscure, and subtile, might be passed over with nothing more than a reference to some place where they are described. I have taken great pains with the terminology; and have, for the most part, used technical words with a strict adherence to their original meaning.

Much of the difficulty of teaching Auscultation and Percussion to students is due to neglect of this plain rule, which everyone who uses such words may be expected to follow, or to give good reasons for not following.

LONDON,
October 16th, 1877.

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INTRODUCTORY.

PHYSICAL EXAMINATION AND PHYSICAL SIGNS.

THOSE properties of matter, which are recognised by the science of physics, constitute the objects of Physical Examination. Most parts of the body may undergo a physical examination; the immediate results thereby obtained are called Physical Signs.

The present book is devoted to an exposition of the methods and results of physical examination of the organs contained in the thorax; namely, of the lungs and pleuræ, the heart and pericardium, and the mediastinum, including the large bloodvessels.

The First Part treats of the physical signs considered in the abstract; the pure science of the physical signs.

The Second Part treats of the physical signs considered in their subservience to the discovery of disease; the applied science of the physical signs.

PART THE FIRST.

CHAPTER I.

METHOD OF EXAMINATION.

SUPPOSE a patient with the chest exposed, ready to undergo a physical examination: the physician first of all carefully surveys the chest with his eye, this is Inspection: next, with his hand, this is Palpation: he next strikes the chest, Percussion: and lastly he puts his ear to the chest, Auscultation.

Whenever convenient, the patient should remove all clothes from the upper part of the body down to the waist, and stand opposite to the physician. Needful deviations from this rule will be suggested by the good sense of the examiner at the proper time and place. Children who are not able to stand strongly should be stripped naked and held in the arms of a

nurse. The physical examination of children is not more difficult than that of older persons: and the method in all cases is the same.

CHAPTER II.

INSPECTION.

INSPECTION discovers the shape of the chest. First; the shape such as it is when the thorax is at rest; that is to say, at the end of an ordinary expiration and during the diastole of the heart. Secondly; the ceaseless temporary changes in shape which the chest undergoes during life, in consequence of the respiratory and circulatory movements.

SECTION I.

SHAPE OF THE CHEST AT REST.

A transverse section of the chest upon a horizontal plane approaches to the figure of an ellipse; between the long and short axes of which (that is to say, between the breadth and depth of the chest) there is a certain proportion in length. A knowledge of this proportion is the key to a knowledge of the shape of the chest in health, and the unilateral and bilateral

changes which that shape undergoes in disease. Changes in the length or height of the chest from above downwards, changes in the direction of the ribs, in the width of the intercostal spaces, in the size of the costal angle, in the arching of the spine and sternum, in the height of the shoulders, and in the projection of the shoulder blades ; all these follow changes in the shape of the horizontal ellipse, as the shadow follows the substance.

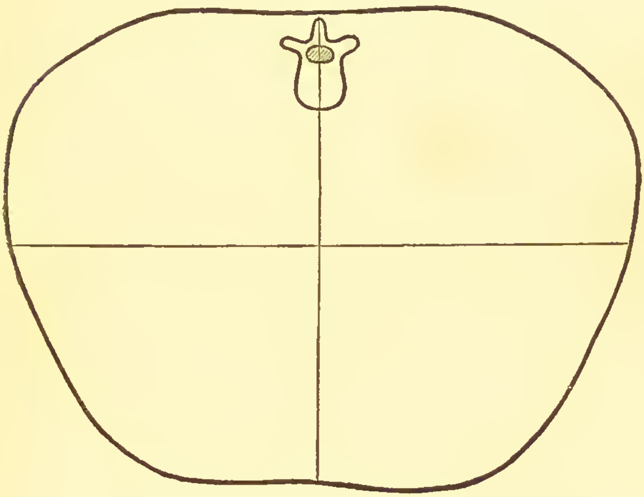
When the axes of the ellipse are nearly equal in length, and the horizontal plane is nearly circular in outline, the chest is short from above downwards (the floating ribs being excluded from consideration), the ribs approach the horizontal, the intercostal spaces in front are narrow, the costal angle is obtuse or open, the sternum is arched, the shoulders are high, and the scapulæ lie flat on the ribs. On the other hand, in proportion as the transverse axis of the ellipse exceeds in length the anteroposterior, the chest becomes long, the ribs slope downwards, the intercostal spaces in front are wide, the costal angle is acute, the sternum is straight, the shoulders are low, and the corners of the shoulder-blades project from the ribs. The former is the chest of inspiration or expansion,

the latter is the chest of expiration or contraction.

ARTICLE I.—SHAPE IN HEALTH.

It is easy to conceive an idea or a type of what the perfect human chest should be. But

Fig. 1.



Circumference = 89 centimeters.

Transverse section of healthy adult chest upon level of sternoxiphoid articulation.

the ideal shape is seldom realised: deviations from the type are present in nearly all persons, who nevertheless may be in soundest health. The more important of these deviations I shall describe under the title of sub-typical.

¶ I.—THE TYPICAL SHAPE.

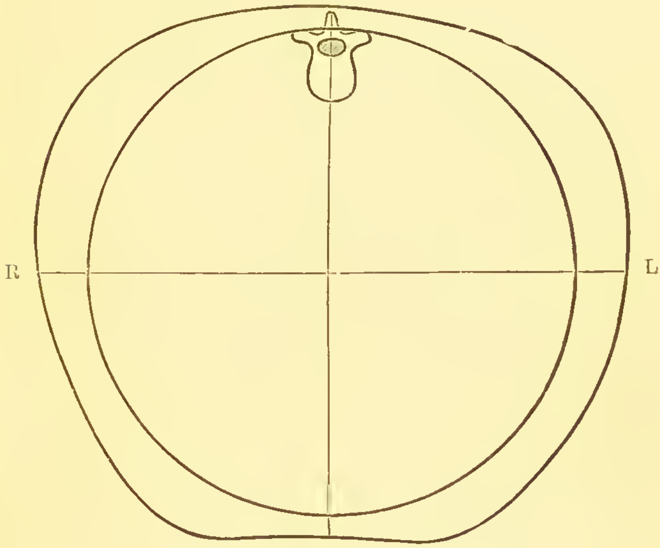
In new-born children the axes of the ellipse are almost equal; the thorax is nearly as deep as it is broad, and is not far from circular. As growth proceeds the breadth of the chest increases more quickly than the depth; so that, by the time the child has cut his milk teeth, a strongly elliptical shape is established. The disproportion between the axes becomes greater and greater (but with diminishing rate of yearly increase) until the body is fully developed. After maturity no further changes occur, until those morbid conditions, which are the almost necessary companions of old age, begin, in most persons, to alter the typical shape, and to make the chest acquire, in the second childhood, much the same figure that it had in the first.

The Cyrtometer is an instrument by means of which the shape of the chest may be exactly ascertained and registered. Originated, both in notion and in name, by Andry[1] and Bouillaud, it was by Woillez that the cyrtometer was first

[1] So Woillez says. There is no reference to the cyrtometer in Andry's book, which is entitled, "Manuel pratique de percussion et d'auscultation." Paris, 1844.

made really useful in physical diagnosis. The cyrtometer of Woillez[1] consists of a number of

Fig 2.



Circumference = 40·5 centimeters.

Transverse section of chest of an infant aged 9 months.
(A circle drawn within the tracing for the sake of comparison.)

small pieces of whalebone rivetted together so as to form two jointed girths, which may be accurately applied to the two sides of the chest, and which are easily fastened and unfastened before and behind by a simple arrangement. I

[1] Recherches cliniques sur l'emploi d'un nouveau procédé de mensuration dans la pleurésie. Paris, 1857.

have found that a cheap and perfect cyrtometer may be made by two pieces of composition gas-pipe, drawn out to a diameter of the eighth of an inch, and united by a piece of caoutchouc tubing. The advantage of the composition alloy is that it possesses very little resiliency. A few experiments with the cyrtometer are all that is necessary in order to become skilful in its use. The instrument, after having been accurately applied to a given circumference of the chest, is removed, and will then afford an exact tracing of that circumference. It is needless to add that the cyrtometer is the best means of measuring the chest.

In order to illustrate the statements just made respecting the different shapes of the thorax at different ages, I will give some actual measurements, taken upon the level of the sternoxiphoid joint, and so calculated that the circumference always = 100.

Age.	Actual circumference.	Ratio of diameters to circumference.	
		Antero-posterior.	Trans-verse.
3 months ...	$14\frac{3}{4}$ inches (37·5c.)	26	29
2 years	18 ,, (45·75c.)......	26	32
34 years	$29\frac{3}{5}$,, (75c.)	26	35
48 years	35 ,, (89c.)	27	31

The chests measured being all perfectly healthy, saving the last which was emphysematous.

The semicircumference of the right half of the chest is usually a trifle greater than that of the left; the difference being from a quarter of an inch to an inch. The nipples are seated on the fourth ribs or the fourth interspaces. Where the manubrium joins the body of the sternum there is often a well-marked angle, angulus Ludovici, level with the second rib.

It is convenient to regard the chest as mapped out by certain vertical lines, whereby we can indicate the exact longitudinal situation of any physical sign. The following vertical lines will be found sufficient: the midsternal, right or left side-sternal, parasternal (i.e. midway between the side-sternal and nipple lines), nipple, mid-axillary, scapular (i.e. the angle), and the vertebral groove. The horizontal level or latitude is indicated by reference to the clavicles, ribs, intercostal spaces, nipples, and sternoxiphoid articulation.

¶ II.—SUBTYPICAL SHAPES.

There are certain deviations from the typical shape of the chest which are present in a large number of persons free from any disease of the

thoracic organs. And, partly for this very reason, but chiefly because these deformities do indicate pulmonary disease in the past, or a tendency to it in the future, they are worthy of all our attention. They are of five kinds, to wit, the alar or pterygoid, the flat, the transversely constricted, the pigeon, and the rickety chests.

i. THE ALAR CHEST.—It has been known from of old that many persons predisposed to phthisis manifest their predisposition by an unnaturally small chest. Projection of the angles of the scapulæ, so as to look like wings, is one sign of the small capacity of these chests, which are therefore called alar or pterygoid by Galen and Aretæus.[1] The thorax of phthinodes (persons predisposed to phthisis) is, as Galen says, narrow and shallow; the anteroposterior diameter is especially small. This diminution in caliber is brought about by drooping, or undue obliquity of the ribs, hence the shoulders fall, and the length of the thorax from above downwards

[1] Hippocrates: Epidemics, bk. vi. sect. iii. par. 9 (edit. Foes.).

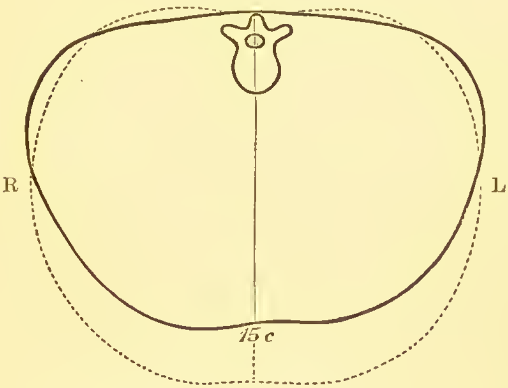
Galen: Comment. in Hippocr. Epidem. i. pag. 62 (edit. Kühn. 1823).

Aretaeus: Caus. et sign. morb. chron. bk. i. ch. 8.

Boerhaave: Aphor. 1198, & Van Swieten's commentary.

is increased; it is the falling of the shoulders which causes the alar appearance. The pterygoid chest is often accompanied, as Aretæus

Fig. 3.



Circumference = 59·5 centimeters.

ALAR THORAX

Tracing taken from a child. The dotted line indicates the shape of the chest of a healthy child of the same size. The circumferential measurement refers to the alar thorax.

says, with a prominent throat, due to a long neck, and the head being carried unduly forwards.

ii. THE FLAT CHEST.—The diminution in capacity presented by the alar chest does not necessitate any great change in the outline which a horizontal plane of the thorax naturally presents. But sometimes not only the size of the

sectional area but its shape also is changed, by the cartilages of the true ribs losing their curve and becoming straight. In which case the chest looks quite flat in front instead of being rounded, the horizontal ellipse is flattened from before backwards, nay sometimes the sternum is depressed below the level of the cartilages so that a section would be somewhat kidney-shaped, the cartilages being curved in the wrong direction. In other respects the flat chest mostly presents the characters of the alar thorax; but this is not always the case, inasmuch as the alar appearance is due to increased obliquity of the ribs and falling of the shoulders, conditions which are not always present even in a well-marked flat chest, the diminution of capacity being otherwise brought about. Flat chests also indicate a phthisical disposition.

Both the phthinoid chests (alar and flat) are often modified in shape by the presence of the transverse constriction to be hereafter described. And both are, as Van Swieten says, essentially the same as the actually phthisical chest, but deformed to a less degree; moreover the loss of fat and muscle which occurs in phthisis makes all the characters described more obvious.

The phthinoid chests are Natural deformities,

the tendency to which is born with the individual and inseparable from him. I now come to the Accidental deformities of the chest, those which have been produced by actual disease subsequent to birth, and not as a matter of necessity.[1]

iii. TRANSVERSE CONSTRICTION OF THE CHEST. A deformity from which few persons are wholly free. It consists in a depression, more or less deep, of the chest walls anteriorly, which passes outwards and slightly downwards, on both sides, level with the xiphoid cartilage, and ceases gradually towards the mid-axillary line.

Produced during childhood, the groove simply persists in after years. Its immediate cause is an impediment of some duration to the inspiration of air sufficient to distend the whole of the chest; the air fails to expand the bases of the lungs. Catarrh is that impediment in the vast majority of cases. Nor need the catarrh be at all severe, or the impediment at all great, inasmuch as a necessary concurrent cause of the groove is found in the yielding character of the

[1] "Naturalem formationem eam appello quæ sit cum pectore constricto, longo collo, et humeris alatis; accidentalem vero quæ sit cum curvitate seu distortione pectoris." Morton: Phthisiologia; bk. ii. chap. i. Lond. 1689.

ribs during infancy and early childhood, and especially of ribs rendered (as they so often are) præternaturally yielding by rickets.

When the impediment is severe and protracted, the depression, although proportionally great, ceases to exist alone; other deformities are produced, and all together go to make up the pigeon breast.

But when the deformity stops short of a pigeon breast, that is, when the depression is not so great as to involve the whole of the front base of the thorax from the xiphoid level downwards, it is the abdominal viscera which determine the position of the sulcus by maintaining the expansion of the base of the chest. The depression occurs as low down as possible, namely, immediately above the upper surface of the abdominal viscera, or what comes to the same thing, the sulcus corresponds to the vault of the diaphragm. This fact led Harrison[1] to propose the sulcus as an easy means of determining the upper margin of the liver. But be it remembered that the groove indicates what was the upper margin of the liver in early life;

[1] On physical signs. London Medical Gazette, vol. xix. p. 369, Dec. 10, 1836.

Errors of Laennec and others respecting the regions of the chest. Ibidem, p. 776. 1837.

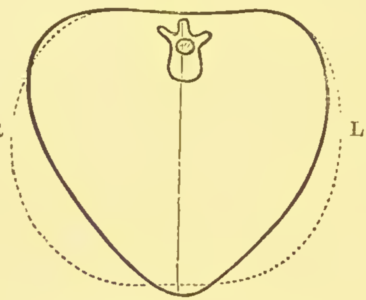
and although no doubt the relationship of the parts concerned is scarcely altered in adult age, excepting from disease, yet it is clear that whatever changes the position of the liver after the furrow has been formed does not change the position of the furrow itself. However, for this very reason, albeit the groove and upper margin of the liver have ceased to correspond, the groove remains a valuable physical sign, indicative of what was the position and what the extent of the liver before the parts ceased to correspond.

iv. THE PIGEON BREAST.—The essential character of the pigeon breast is a straightening of the true ribs in front of their angles. Necessary consequences of this deviation from the natural shape are, first, that the sternum is thrown forwards, and next, that the greatest transverse diameter of the chest recedes towards the costal angles, that is, that the horizontal section tends to pass from the ellipse into the triangle.

The cause of the straightness of the ribs is a long existing or frequently recurring impediment to free inspiration while tho ribs are plastic, that is, during childhood; and especially when they are præter-naturally yielding, that is, when rickety. Chronic pulmonary

catarrh (including whooping cough) and chronic enlargement of the tonsils are the common causes

Fig. 4.



Circumference = 57·5 centimeters.

Pigeon Breast.

Tracing taken from a child of seven years. Dotted line indicates natural shape at same age.

of pigeon breast:[1] the deformity may be easily seen in process of formation by watching the chest of a child during the long-drawn inspiration of whooping cough.

But obstruction to inspiration was pronounced to be the cause of the transversely constricted chest. And so a pigeon breast is mostly accompanied by a well-marked transverse sulcus: as a part of which transverse constriction, the xiphoid cartilage becomes bent back so as to

[1] Dupuytren: Mémoire sur la dépression latérale des parois de la poitrine chez les enfants. Breschet's Repertoire générale d'anatomie: vol. v. p. 110. Paris, 1828.

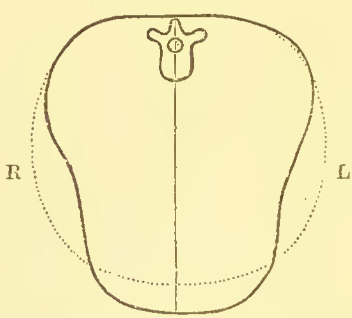
form a more or less sharp angle at the bottom of the sternum; a condition which increases the similarity to a pigeon's breast. The transverse furrow, I say, is well marked; in fact, very often there is a depression of the whole anterior half of the thorax below the xiphoid level; in which case, the straightening of the false ribs, in front of the angles, is carried to an extreme degree. This flattening below Harrison's sulcus is partly due to the fact that a deep inspiration involves the upper thorax chiefly.

The costal cartilages of a pigeon breast are often more prominent on the right side than on the left; a condition commonly connected with more or less scoliosis in the dorsal vertebræ. And there is yet another reason for this inequality, which depends upon the cause of the pigeon breast, that is to say, upon catarrh and its consequences. For on the right side we find lung, free to dilate, where, on the left side, lies the heart.

v. The Rickety Chest.—Rickets, on account of the part which it takes in the generation of the transversely constricted and of the pigeon chest, has already been alluded to more than once: it remains to show how rickets alone may produce deformity of the chest.

Rickets is a disease of infancy, and infants cannot but have a respiration chiefly abdominal, because of the circular shape of their thorax, which does not admit of further lateral expansion. When the diaphragm descends, and rarefies the air contained in the lungs, the rickety ribs, not being able to hold out until the chest is completely distended by fresh air passing in through the glottis, yield in their softest parts to the atmospheric pressure from without, and are bent inwards. Inasmuch as the softest parts

Fig. 5.



Circumference = 42·75 centimeters.

Rickety Chest.

Dotted line indicates shape of chest in an infant of about the same age.

of the ribs are at and near their costochondral articulations, a shallow longitudinal groove is formed on each side of the chest, parallel and

a little external to the sternum : a groove which may be formed without the least direct impedi-ment to the entry of air through the air-pas-sages.

But in rickets the whole ribs are softened more or less, and hence when the causes of a transverse groove or of a pigeon breast are present in a rickety child, the resulting deformity is exaggerated.

Deformities of the chest which are purely rickety tend to disappear to a remarkable degree as the health improves : deformities of more complex origin are more permanent.

Article II.—Shape in Disease.

Having described the deviations from the natural shape of the chest which are com-patible with a healthy state of its contents, I now come to those changes in shape which indicate disease of the thoracic viscera. Changes of this latter kind may be reduced into three classes, namely, bilateral, unilateral, and local. The former two classes of change indicate disease of the lungs or pleuræ : the last class of change may be caused by disease of lungs, heart, serous membranes, or mediastina.

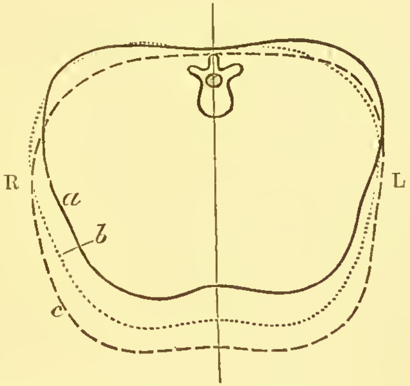
¶ I.—BILATERAL CHANGES IN SHAPE:

are of two kinds, enlargement and diminution.

i. Bilateral Enlargement.—By the deepest inspiration (in other words, by the greatest elevation and rotation of the ribs) no considerable modification can be produced in the proportion between the length of the two axes of the horizontal ellipse. In order to render further enlargement of the thorax possible the ribs must change their shape; they become more curved: the axes of the ellipse tend to become equal; the ellipse tends to pass into the circle; changes which are explained by the fact that of all figures possessing a periphery of fixed and certain length, the circular is that which includes the greatest area; depart from the circle in any way and the area becomes less. It is a fact which must be clearly understood; that the chest admits of an enlargement far beyond that which can be produced, when the lungs are healthy, by the deepest inspiration. It is a mistake to suppose that the bilaterally enlarged chest is merely in a state of permanent inspiratory expansion. The experiment indicated by the diagram on the next page is decisive

upon this point. Moreover Freund[1] has shown that, in an emphysematous chest, there is some-

Fig. 6.



Horizontal section of chest of a child two years old.

a = chest at rest.
b = chest after fullest expansion possible of lungs.
c = chest after forcible injection of air into both pleural cavities.
Anteroposterior diameters :

a = 10·2c. *b* = 11·7c. *c* = 13·2c.

Circumferences :

a = 47·5c. *b* = 48c. *c* = 48·5c.

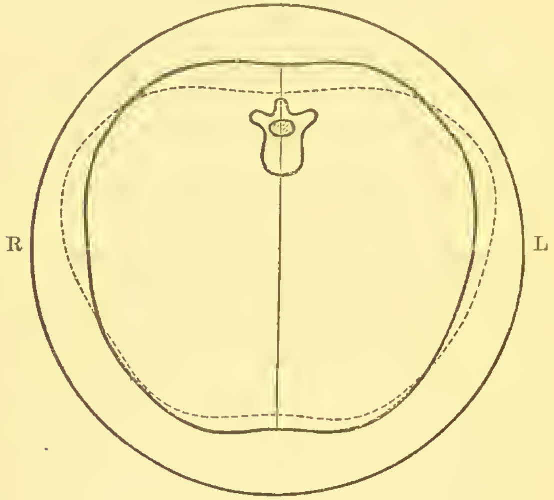
times an actual increase in the length and breadth of the costal cartilages.

Enlargement of the chest signifies enlargement of its contents : the only possible causes of bilateral enlargement are emphysema of the

[1] Der Einfluss der primären Erkrankungen des knorpligen Thorax auf Entstehung gewisser Lungenkrankheiten. Würzb. Verhandl. 1859. Bd. ix. p. 223.

lungs (whether a permanent, or a merely temporary distension of the air-vesicles,) and a large effusion of fluid into both pleuræ. Now the latter state is incompatible with life, and so a bilaterally enlarged chest, and the chest of emphysema come to be convertible terms.

Fig. 7.



Bilateral Enlargement of Emphysema.

Inner line = emphysematous chest.
Outer line = a circle drawn to show how nearly the emphysematous approaches the circular shape.
Dotted line = natural adult chest.
Actual measurements in centimeters :

Circumference	= nat.	89·	emphys.	87·75
Transverse	= ,,	29·6	,,	27·25
Anteroposterior	= ,,	22·25	,,	25·4

In a well-marked case of emphysema, then, the thorax is in a state of distension beyond

what could have been produced during health by the deepest possible inspiration. The chest is almost cylindrical or globular, arched before and behind. The arching is usually most marked in the sternum, and is simply the result of the fact that the sternum is less able to move forwards above than below: the manubrium and body of the breast-bone become bent at an angle, the angulus Ludovici. But sometimes the spine is much more arched than the sternum, and this may be the case to such an extent, in a thorax highly emphysematic, that the sternum shall be nearly straight, and the front of the chest apparently flat, in consequence of the shoulders being thrown forwards by the stooping of the vertebræ.

The bilateral enlargement sometimes involves the whole length of the thorax, and then the cartilages of the false ribs are everted, and the costal angle is greatly increased in size. But sometimes the enlargement affects the chest above the xiphoid level only; the parts below being tolerably natural, or even depressed: when they are depressed, the transverse constriction is well marked, and the costal angle is diminished in size. The causes of the depression are the same as described when speaking

of pigeon breast; very little air enters, what does enter goes to the upper parts; the respiration is superior-thoracic. Indeed this shape is usually due to subsequent bilateral distension of the upper part of chests which were wholly pigeon breasted early in life.

Kyphosis of the dorsal spine, whether senile, or due to the carrying of heavy weights upon the shoulders, or to caries of the vertebræ, is attended by a shape of chest which strongly simulates emphysematous enlargement.

It is instructive to compare the raising of the shoulders and the non-prominence of the shoulder-blades with the opposite conditions in the opposite form of chest, the pterygoid.

In the acute emphysema of the anterior part of the lungs, which attends the suffocative bronchitis of children, a bilateral distension of the front of the chest may take place in a day or two. When the catarrh becomes chronic, the chest is often a long time before it regains its natural shape.

ii. Bilateral Diminution.—The diminution is greater than can be produced in a healthy chest by the deepest expiration. The characters of the chest are in all points the same as those of the flat phthinoid chest but carried to a greater

pitch. Phthisis is the only disease in which great diminution of both sides of the thorax occurs; as Aretæus says,[1] the chest becomes broader (*i. e.*, in the transverse diameter), yet the patients stand in need of its being broader still (*i. e.*, in the anteroposterior diameter).

¶ II.—UNILATERAL CHANGES IN SHAPE.

These, like the bilateral, consist in enlargement and diminution.

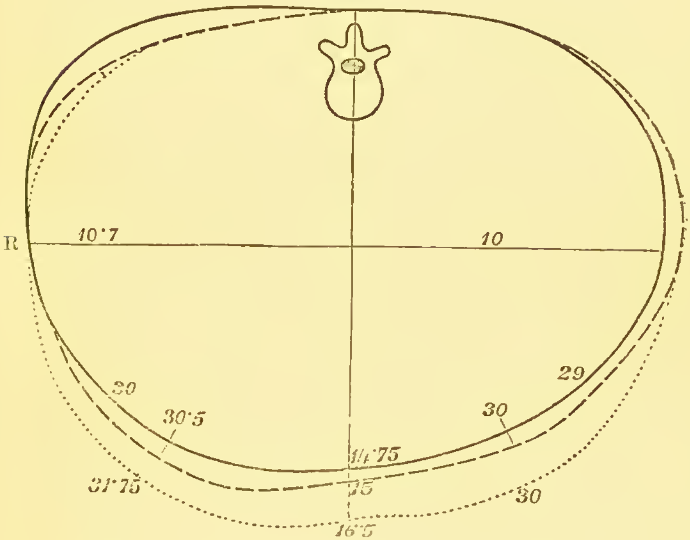
i. UNILATERAL ENLARGEMENT.—The notes of bilateral enlargement already given are applicable to enlargement of one side only of the chest. The side enlarged, compared with the other, will present these characters: shape rounder; transverse semidiameter shorter, and anteroposterior diameter longer; length, from above downwards diminished, shoulder raised; spine curved towards unaffected side. I say that the length of the chest from above downwards (the vertical diameter) is diminished, and this is true, provided that the floating ribs be excluded from consideration: let any one who doubts this statement inject the pleura of a dead subject with air, and watch the changes which ensue. The anteroposterior en-

[1] Caus. et sign. mb. diut. bk. i. chap. 10.

largement becomes very obvious when the physician stands behind the patient so as to look obliquely over his shoulders and the front of his chest. In children the best notion of the enlargement and roundness of the affected side is gained by grasping both sides with the two hands, the thumbs being placed tip to tip upon the spines of the vertebræ. Circumferential measurements of the two sides are often made, but be it remembered, first, that considerable increase in the sectional area of the chest may occur, and the length of the periphery remain the same, by the passage of the elliptical form into the circular: and next, that the displacement of the mediastinum, which accompanies unilateral enlargement, thrusts the heart into the unaffected side. Add this consideration too, that the walls of the healthy side must follow the anteroposterior projection of the diseased side: and then it will be plain why, as a matter of fact, the perimeter of the expanded side often measures very little more, nay even less, than that of the side which is not diseased. The cyrtometer alone, by indicating shape as well as circumference, affords us the true means of recording the amount of a unilateral enlargement.

The causes of bilateral and unilateral enlargements are the same, namely, increase in the size of the lung, and effusion of fluid into the pleura. Increase in the size of one lung occurs in vicarious hypertrophy compensatory of chronic

Fig. 8.



Unilateral enlargement of chest (right side); artificially produced by injecting air into the right pleural cavity.

Unbroken line = outline before injection.
Broken line = outline after moderate distension.
Dotted line = outline after extreme distension.

Figures, at bottom of vertical line indicate the anteroposterior diameters: along horizontal line indicate transverse semidiameters: remaining figures indicate right and left semicircumferences.

disease whereby the other lung is put out of play; in rapidly growing soft cancer of the lung;

and, according to Woillez,[1] in active sanguineous fluxions upon the lung: unilateral hypertrophous emphysema, the other lung being healthy, is impossible. Effusion of fluid into the pleura, however, causes the greatest enlargement: inflammatory effusion, pneumothorax, extensive hæmothorax.

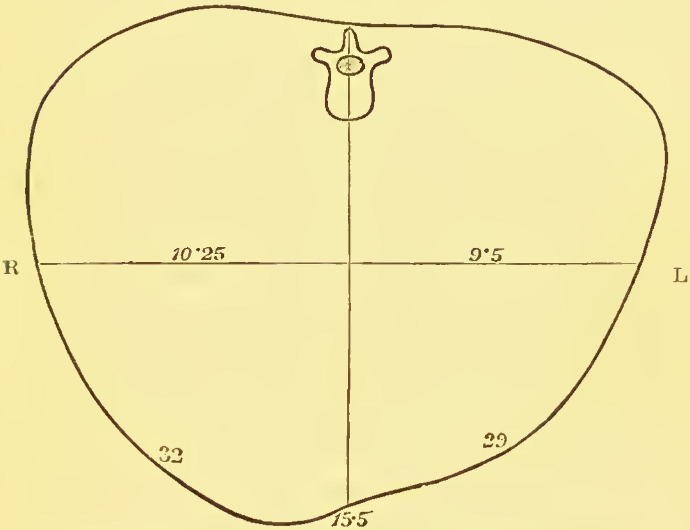
ii. Unilateral Diminution.—In unilateral shrinking of the chest the circumference and the anteroposterior diameter are diminished; the transverse diameter increased; the side looks flat before and behind, having lost its rounded shape and become angular; the ribs are closer together than natural; the shoulder is lower; and the spine curved towards the healthy side. The perimeter of the contracted side is diminished; and, when there is vicarious enlargement of the other lung, the difference between the circumference of the two sides becomes very great.[2]

[1] Recherches cliniques sur la congestion pulmonaire. Archives gén. de méd.: series vi. vol. viii. Aug. to Dec., 1866.

[2] In a case of excessive unilateral contraction of the chest, consequent upon empyema, and associated with distension of the other side, I noted that a very powerful inspiratory expansion and forward movement of the distended side was accompanied with distinct recession and backward move-

Unilateral diminution of the chest, when chronic, is always attended by an adherent pleura; a condition itself the result of past pleurisy, of phthisis, or of cancer. An acute

Fig. 9.



Unilateral retraction of chest: consequent upon cirrhosis of left lung in a girl of fourteen. Figures as in last sketch.

unilateral shrinking of the chest occasionally occurs in children, as a consequence of collapse of one lung due to an obstruction of the main bronchus.

ment of the front of the contracted side, as if it were drawn upon and straightened.

Scoliosis sometimes induces a shape of chest which, when regarded from the front or from the back alone, strongly simulates unilateral contraction. The cause of this is to be found in the rotation of the vertebræ round their longitudinal axis. The side which looks contracted in front is protuberant behind, and vice versa.

¶ III.—LOCAL CHANGES IN SHAPE,

namely local bulging and shrinking.

i. Local Bulging.—Bulging of a part of the chest walls is met with in circumscribed pleural effusions, in pericardial effusions, in large phthisical excavations, in hernia of the lung, in hypertrophy and dilatation of the heart, in pointing empyemata, in aneurysms, in cancerous, hydatid, and other tumours.

The bulging indicative of cardiac or pericardiac enlargements demands further notice. It occurs between the third and seventh cartilages on the left side, and extends from the left nipple line to the sternum or even to the right nipple line.[1]

[1] Norman Moore has studied this form of bulging with the help of the cyrtometer. Observations on the shape of the chest in cases of hypertrophy of the heart. London, 1873.

ii. Local Shrinking.—Shrinking of a part of the chest walls, when due to intrathoracic disease is usually attended, like unilateral contraction of the whole chest, by pleural adhesions. Shrinking of the apex of one side is very common in phthisis.

There is a condition, frequently met with, which has never been explained, and which is difficult of explanation; I refer to a great cup-like depression of the lower part of the sternum and of the attached cartilages. The pit is sometimes so broad as to reach up to the level of the third rib; and sometimes so deep that it seems as if the bottom must almost touch the spinal column. I have known this deformity to follow unilateral pleurisy, and yet to be perfectly symmetrical; even although one side only of the chest was contracted. Whooping cough may set up a hollow of this kind. Croup, in infants, is often attended by enormous inspiratory recession of the whole corpus sterni below the angulus Ludovici: whence I infer that a chronic catarrhal obstruction to inspiration may cause, in some cases, this crateriform depression instead of the more usual pigeon breast: the angle produced by the horizontal constriction occurs higher up than usual. Rickets, no doubt, would

be auxiliary. A slight degree of a similar deformity is found in many shoemakers: in whom it is due to pressure from without. Graves tells of a young man whose sternum was so yielding that it could be easily pushed back so as to make a cupping just such as I have described.[1] When the deformity follows whooping cough or pleurisy, there is hope that it may disappear in the course of time: yet sometimes the depression remains through the whole of life.

SECTION II.

MOVEMENTS OF THE CHEST.

These are of three kinds, movements of respiration, movements of the heart, and movements wholly unnatural.

Article I.—Movements of Respiration.

¶ I.—IN HEALTH.

Healthy breathing, and its varieties, according to age and sex, are subjects so fully discussed by physiology that they may be passed by in this place.

Great is the number of instruments which

[1] Clinical Lectures on the Practice of Medicine. 2nd edit. vol. ii. p. 521, Lecture 68. Dublin, 1848.

have been invented for registering the respiratory movements and powers: stethographs, stethometers, thoracometers, spirometers, pneumatometers, anapnographs: a field of study which seems to be uncommonly barren, if we compare the outlay of toil and wit with the scanty yield to diagnostics.

¶ II.—IN DISEASE.

Mere increase and mere diminution of respiratory movement, bilateral, unilateral, or local, scarcely demand a long notice. Perversions in the character of the movement are more important: they may be arranged under five heads, inspiratory dyspnœa, expiratory dyspnœa, non-expansive inspiration, respiration wholly thoracic, and respiration wholly abdominal.

[1] The whole literature of the subject may be found in the following books:—

Ransome: On stethometry; being an account of a new and more exact method of measuring and examining the chest, with some of its results in physiology and practical medicine. London, 1876.

Riegel: Die Athembewegungen. Würzburg, 1873.

Waldenburg: Die pneumatische Behandlung der Respirations- und Circulations-krankheiten im Anschluss an die Pneumatometrie, Spirometrie, und Brustmessung. Berlin, 1875.

i. Inspiratory Dyspnœa.—It is when the chest-walls are yielding that inspection affords the most convincing sign of inspiratory dyspnœa; namely, a recession, more or less deep, of the front of the thorax below the level of the nipples. The causes and mechanism of this recession are identical with the causes and mechanism of the transversely constricted chest. But I speak now of an amount of constriction so great as to be incompatible, for any length of time, with life. Inspiratory dyspnœa, such as this, occurs in obstruction to the passage of air through the larynx or trachæa, in per-acute œdema of the lungs and hydrothorax, and in infants or rickety children even during a common pulmonary catarrh. In the last case, temporary bilateral enlargement of the chest, above the transverse sulcus, mostly concurs with the depression of the parts below. Even unilateral diseases, such as empyema, are sometimes attended, in children, by the bilateral results of inspiratory dyspnœa described above, namely, by great and equal recession of the base of the chest on both sides. In obstruction to the larger air-passages the supraclavicular regions usually partake in the recession.

ii. Expiratory Dyspnœa.—In this condition

the expiratory movement is exceedingly laborious and prolonged. Expiratory dyspnœa is present along with any great impediment to expiration in the upper air-passages; and also occurs whenever the expiratory power of the lungs is diminished, as in emphysema, asthma, and congestion.

iii. Non-expansive Inspiration.—The chest-walls are elevated powerfully, yet expanded little or not at all. This sign may occur, on one side or on both, whenever the texture of the lung is impermeable to air, or non-expansible (as in pleurisy with effusion, pneumothorax, dense pleural adhesions, phthisis, and cancer), or when the thorax cannot be dilated more than it is (as in emphysema). The application of the hand to the chest is very serviceable in the detection of non-expansive inspiration.

iv. Respiration wholly Thoracic. — The female type of respiration carried to the extreme. Occurs in diseases which interfere with the action of the diaphragm: paralysis of the diaphragm, great pericardial effusion, peritonitis, ascites, abdominal tumours.

v. Respiration wholly Abdominal. — The male or infantine type of respiration carried to the extreme: respiration being performed almost

wholly by the diaphragm. Occurs bilaterally in spinal paralysis, and in tetanus; unilaterally in pleurodynia, pleurisy, phthisis.

Article II.—Movements of the Heart.

The chief movement of the heart, detected by inspection, is the Impulse. Systolic recession of certain interspaces is sometimes visible.[1]

¶ I.—MOVEMENTS IN HEALTH.

i. The Impulse.—The movement of any part of the heart, which underlies the chest-walls, may be seen and felt in favourable circumstances. But there is commonly only one impulse in health. The part of the heart which strikes the chest wall appears to be a spot upon the anterior surface of the right ventricle, about three-quarters of an inch above the apex: the apex itself being separated from the thoracic parietes by a layer of lung which is a finger broad.

The Time of the impulse coincides, not with the contraction of the ventricles only, but with

[1] Throughout this book, the word "systolic" means contemporaneous with the systole of the ventricles; "diastolic," with their diastole.

the contraction of the auricles, of the ventricles, and the closure of the semilunar valves. Wherefore the impulse is not exactly systolic, as is commonly taught, but is also præsystolic and postsystolic.[1] Nevertheless it is generally accurate enough to deem the impulse simply systolic.

The Position of the impulse is the fifth left interspace, midway between the nipple and the parasternal lines. In children, under eleven years of age, the heart frequently lies high, so that the impulse occurs in the fourth interspace, and rather more external than in adults, that is to say, in the nipple line. In many old people the heart lies low, so as to beat against the sixth interspace. By a deep inspiration the impulse can be depressed half an inch. By lying upon the left side the position of the impulse shifts to the nipple line, or beyond it. By lying upon the right side the position of the impulse becomes uncertain: other parts of the heart than the apex yield an impulse.

The Extent of the visible impulse is small, not greater than a square inch.

The Force of the impulse is best estimated by palpation.

[1] Landois: Graphische Untersuchungen über den Herzschlag im normalen und krankhaften Zustande; p. 71. Berlin, 1876.

Epigastric pulsation, conducted from the right ventricle, may be caused by a healthy heart throbbing from violent exercise or emotion.[1]

ii. RECESSION OF THE CHEST WALLS.—Is occasionally perceptible, during the systole, in the third, fourth, or even the fifth intercostal spaces on the left side, close to the sternum: this, especially in persons who are very thin.

¶ II.—MOVEMENTS IN DISEASE.

i. THE IMPULSES.—Three kinds of impulse are seen in disease: namely, the apex-beat proper, more or less changed in its characters: an impulse of some part of the right ventricle above the apex-beat, especially the conus arteriosus; and an impulse of the right auricle.

a. IMPULSE OF THE APEX-BEAT.

The Position of the apex-beat may be changed by whatever enlarges the heart or displaces it.[2]

Enlargement of the left ventricle causes the apex-beat to shift to the left of the left nipple line, in the fifth, sixth, or seventh interspace.

[1] The topic of epigastric pulsation is discussed in chap. 6, sect. 4.

[2] Consult the chapters on the Position of the Diaphragm, and of the Mediastinum, with reference to displacements of the heart.

Enlargement of the right ventricle has one or both of two effects. First: the extent of the impulse to the right of the left parasternal line is increased; for the cardiac enlargement causes the lungs to shrink away, so that the impulse of other parts of the right ventricle than the apex-beat comes to the surface, and is seen and felt. Next: the apex-beat may be displaced to the left; the heart retaining its natural position, and the left ventricle being natural in size; but the right ventricle and both auricles being greatly dilated.[1]

Displacement of the heart to the left may be so great as to cause the impulse to beat in the axillary line, and in any interspace from the second to the fifth or sixth. The causes of this kind of displacement are the following: diseases of the abdomen (ascites, tympanites, tumours) whereby the diaphragm is raised, and the heart comes to lie more horizontally than is natural; effusions of air or liquid into the right pleura; tumours to the right of the heart; retraction of the left lung, whether by phthisis, cirrhosis, or old pleurisy.

[1] Markham: A case of disease of the heart, with great dilatation of the auricles. Medico-chirurgical Transactions, vol. xl. 1857.

Displacement of the heart to the right may cause the impulse to be seen anywhere to the left of the right nipple line, in any interspace from the fourth to the seventh, or in the epigastrium. The causes are similar to those of displacement to the left, excepting abdominal enlargement. And, whatever may be the case in dislocations of the heart rapidly produced, there is no doubt that chronic disease may displace the heart so that its very apex-beat shall be felt in the right nipple line.[1]

β. Impulse of the Conus Arteriosus.

Yet when the impulse of a diseased or displaced heart is seen to the right of the natural position, it is often some part of the ventricle, other than the apex, which strikes against the chest; and this part is usually the conus arte-

[1] Case of pyopneumothorax: St. Bartholomew's Hospital: post-mortem book; Sarah B., 22 years old: March 6, 1872. Great bulging of left chest. Abdomen opened: diaphragm greatly depressed, convex downwards. The heart being fixed by a long needle before the thorax was opened, the mediastinum was found altogether forced over to the right, so much so, that the left margin of the heart was two and a half inches to the right of the midsternal line; and the whole heart lay to the right of the costo-chondral articulations of the third and fourth right ribs. In left pleura, two quarts of pus, and much air.

riosus.[1] A white patch, telling of long friction is often seen at this spot, after death.

γ. Impulse of the Right Auricle.

A systolic impulse in the fifth interspace and the right parasternal line may be due to a dilated right auricle.[2] In the case referred to below, the impulse was systolic with respect to the ventricles, and the walls of the auricle were almost destitute of muscular fibre: so that the most probable cause of the impulse was a sudden filling of the auricle with blood, during the ventricular contraction.

The Extent of the impulse (meaning thereby actual contact of the heart with the chest wall) may be increased; and then the movement sometimes takes on a fluctuating or peristaltic character. The causes of a too extensive impulse are these: enlargement of the heart, the lung being pushed aside; shrinking of the lung; and whatever presses the heart against the chest-wall, for instanee a narrow chest, or a tumour in the posterior mediastinum, especially an aneurysm of the descending aorta.

[1] R. D. Powell: Notes on displacements of the heart. British Medical Journal, July 17, 1869.

[2] Markham's ease, before cited. An aneurysm of the ascending aorta may beat in exactly the same situation.

ii. Recession of the Chest-wall.—In hypertrophy of the heart, the recession of the chest above the apex-beat is much more frequently met with than in health. The apex-beat itself is sometimes strongly dimpled inwards during the systole; a sign which is usually thought to indicate the presence of pericardial adhesion, combined with pleural adhesions over the pericardium; for, the heart, being thus fixed to the diaphragm and the mediastinum, manifests the shortening which occurs during the ventricular systole, by dragging the chest walls inward.[1]

Article III.—Movements wholly unnatural.

Movements, that is to say, which have no counterpart in the healthy state. The pulsation of aneurysmal tumours is of this kind.

[1] But see Galvagni: Studio clinico sulla sinfisi cardiaca e sul rientramento sistolico: quoted in Virchow and Hirsch's Jahresbericht for 1873, vol. ii. p. 137. Also an earlier paper by the same author: Jahresbericht for 1869, vol. ii. . 75.

CHAPTER III.

PALPATION.

PALPATION, or the application of the hand to the surface of the chest, is often useful as a means of confirming the notions acquired by the eye concerning the shape, size, or amount of movement of any part of the thorax. But palpation has an independent value, and can detect thrills and impulses which are imperceptible to the eye. These signs will be considered in order as they relate to the lungs and pleuræ, the heart and pericardium, and the large bloodvessels.

SECTION I.

LUNGS AND PLEURÆ.

Article I.—The Vocal Thrill.

¶ I.—IN HEALTH.

When a person speaks, a distinct tremulous sensation may often be felt upon the surface of the chest: the vocal thrill. The intensity of the thrill is in direct proportion to the depth

and loudness of the voice, and therefore is best marked in adult men, and is often absent in women and children. The reason of this seems to be that only in low-pitched notes are the vibrations sufficiently far apart to be perceptible to the hand. The thrill is conducted from the larynx both by the tissues and by the air in the air-passages: it is strongest over the lungs, and is weakened as we pass away from them: the thoracic walls conduct the thrill well when they are not very fat or œdematous. Vocal thrill is naturally more intense on the right side than on the left.

In examining the vocal thrill it is best to make all patients repeat the same sound: the words 'ninety-nine' are very suitable for the purpose.

¶ II.—IN DISEASE.

i. The vocal thrill is diminished or abolished by whatever separates the lung from the chest-wall, and by whatever renders the lung quite impermeable to air. An effusion into the pleura, whether of liquid[1] or gas, is the commonest cause of loss of vocal thrill; but, unless the effusion

[1] This fact seems to have been discovered by Reynaud: see the memoir quoted under the head of Pleural Friction.

be great, the thrill is not wholly abolished, being conducted by the thoracic walls. Solidification of the lung does not materially diminish vocal thrill, except the solidification be very dense. Wherefore ordinary pneumonic and phthisical consolidations do not lessen the thrill, and may even increase it: but pneumonic exudation which packs the lung hard, massive phthisical solidification, and cancer, these abolish vocal thrill, unless indeed a large bronchus be in intimate connection with the solid mass.

ii. The vocal thrill is increased by consolidation which is not too dense, and which is traversed by large open air-tubes.

The thrills produced by cough and rales are of no practical value.

Article II.—Pleural Friction:

May occasionally be felt, but is of no practical importance.

Article III.—Fluctuation.

Fluctuation of a liquid effusion in the pleura may sometimes occur.

i. Fluctuation produced by striking the chest is a physical sign wholly superabundant, inas-

much as a complete diagnosis will have been attained long before the disease has gone so far as to yield the sign of fluctuation. When the intercostal spaces are widened and rendered tense, fluctuation may sometimes be produced and felt by two fingers placed far apart in the same interspace. The splash of hydropneumothorax may be sometimes felt, but is much better heard.

ii. Fluctuation of a pleural liquid effusion is occasionally produced by the action of the heart: for the diagnosis of this condition see the chapter on empyema.

SECTION II.

HEART AND PERICARDIUM.

Article I.—The Impulse.

¶ I.—SYSTOLIC IMPULSES.

Palpation will serve to confirm the information yielded by the eye as to the position and the extent of the impulses of the heart against the chest wall. Sometimes an impulse is palpable when it is not visible.

Palpation moreover enables us to say whether the force of the impulse is weaker or stronger than natural.

i. The force of the impulse is diminished by whatever weakens the heart, and by whatever separates it from the chest-wall. Great diminution in the force of an impulse which has been heaving is an important sign of asystolism.

ii. The force of the impulse when increased, that is to say, a heaving impulse, is much better appreciated by applying the stethoscope and head to the apex-beat, than by the hand alone.[1] A knowledge of this fact was the immediate forerunner of the discovery of auscultation. When the heaving impulse is well marked, it is able to overcome the greatest pressure which the patient can bear, and may be regarded as a sure and certain sign of cardiac hypertrophy. The mere knocking of a palpitating heart is easily distinguished from true heaving.[2]

The force of an impulse is much influenced by the thickness of the thoracic parietes, the position of the body, the tone of the heart, and the relative situation of the lungs.

The Cardiograph (an instrument, invented by Chauveau and Marey,[3] whereby the move-

[1] Laennec: Auscultation médiate. 2nd edit., vol. ii. p. 394.

[2] Laennec: ibidem, vol. ii. p. 397.

[3] Chauveau et Marey: Démonstration nouvelle du méca-

ments of a cardiac impulse may be registered), has confirmed or revealed the truth of the following propositions :—

That the contraction of the auricles immediately precedes that of the ventricles: That the systole of both ventricles is exactly synchronous: That the impulse coincides with the contraction of the auricles and ventricles, and the closure of the semilunar valves : That the second sound follows immediately upon the ventricular systole : That the auriculo-ventricular valves vibrate during the greater part of the ventricular systole : That the closure of the aortic semilunars precedes that of the pulmonary semilunars.

¶ II.—DIASTOLIC IMPULSES.

Diastolic cardiac impulses are of two kinds :

i. Sudden relaxation of the ventricles, after a

nisme des mouvements du cœur par l'emploi des instruments enregistreurs à indications continues. Mém. de l'Acad. de Méd. Paris, 1861. Marey has published several later works upon the same subject. His cardiograph is depicted and described in Kirkes' Physiology, by W. M. Baker : 9th edit. p. 158. 1876.

Galabin : On the construction and use of a new form of Cardiograph. Med. Chir. Trans., vol. lviii. 1875.

Landois : Graphische Untersuchungen über den Herzschlag im normalen und krankhaften Zustande. Berlin, 1876.

powerful contraction, sometimes causes a sort of diastolic impulse; the back-stroke, as it was called by Hope.[1] This most frequently occurs in hypertrophied hearts.

ii. Sudden closure of the pulmonary sigmoid valves sometimes causes a sharp invisible diastolic impulse, which is to be felt at the second left interspace close to the sternum. This sign indicates the presence of solid lung over the pulmonary artery, or that the lung has shrunk away from it, or that there is an unusually high pressure in the artery. The last cause is the commonest; is usually present in disease of the mitral orifice, and occasionally even in perfect health; and is attended by a loud pulmonary second sound.

¶ III.—PRÆSYSTOLIC IMPULSE.

It is said that the contraction of the auricles, when they are much hypertrophied, may give rise to a short præsystolic impulse at the base of the heart. An auricular impulse which is systolic, the auricle being passive at the time, has already been referred to.

[1] A treatise on the diseases of the heart and great vessels. 3rd edit. pp. 67, 272. London, 1839.

Article II.—Valvular Thrills.

A valvular thrill is a quivering sensation felt by the hand applied to the region of the heart in certain forms of disease. The likeness to the purring of a eat led Laennee[1] to invent the name "frémissement eataire" for the phænomenon: by its diseoverer, Corvisart, it had been before deseribed under the term "bruissement."[2] For a thrill to be of value as a physieal sign it must be well marked: what may be considered a well-marked thrill ean be learnt by experienee alone.

Thrills are palpable murmurs, and are due to the same physieal eondition; that is to say, to the vibration of a fluid vein. The vibration must be strong and slow in order to be palpable. The solids also must be apt for eonduction; in other words, apt for eonvibration: they must be elastic, tolerably homogeneous, and of a eertain mean tension. Along fluid eurrents, thrills are conducted according to the laws of murmurs.[3]

[1] Traité de l'auscultation médiate et des maladies des poumons et du eœur. 2nd edit. ii. p. 448. Paris, 1826.

[2] Essai sur les maladies et lésions organiques du eœur et des gros vaisseaux. 2nd edit. p. 232. Paris, 1811.

[3] Refer to the article on Murmurs in general, and to that on the conduction of Percussion sounds.

Thrills, like murmurs, are of many kinds, and must be distinguished according to their place and time: thus—

i. Thrills felt in the second right intercostal space, close to the sternum, or at the episternal notch: indicative of a lesion at the aortic orifice. Systolic, the orifice is obstructed: diastolic, the valves are incompetent.

ii. Thrills felt in the second left intercostal space, or over the third left costal cartilage, close to the sternum: indicative of a lesion at the pulmonary orifice. Systolic, the orifice is obstructed: diastolic, the valves are incompetent. Here, however, it must be noted that, in aortic regurgitation, the heart may be displaced so much to the left, that a diastolic thrill, produced at the aortic orifice, shall be felt to the left of the sternum, in the second and third interspaces.

iii. Thrills felt at the apex-beat: indicative of a lesion at the mitral orifice. Systolic (not a mere quivering impulse, but a thorough thrill), the valves are incompetent: præsystolic (running up into the impulse, and brought to an end thereby), or diastolic (alternating with the impulse, pendulum-like), the orifice is obstructed.

iv. Thrills felt over the fourth left costal cartilage, or in the fourth left interspace, close to the sternum: indicative of a lesion at the tricuspid orifice. Præsystolic, the orifice is obstructed.[1]

v. Thrills felt in the fifth interspace and parasternal line on the right side: systolic: due to the sudden rush of blood into a distended right auricle.[2]

Concerning the explanation of the place and time of these many thrills, I may refer the reader to the chapter on Endocardial Murmurs: all that is said on these topics with regard to the murmurs, applies to the corresponding thrills. It may be well to remark, that thrills felt to the right of the sternum are often due to aortic aneurysm.

Article III.—Pericardial Friction.

It is not at all uncommon to be able to feel

[1] Gairdner: Complicated cases of cardiac murmur: Edinb. Med. Journal: v. 871. Feb. 1860.

Haldane: Cases of disease of the tricuspid valve: Edinb. Med. Journal: x. 271. Sept. 1864.

An aortic aneurysm, which opens into the pulmonary artery, may cause a thrill in this place: see Wade's paper referred to hereafter.

[2] Markham's case, before cited.

the rubbing of pericardial exudations : a matter of small practical value. Friction is usually very unlike valvular thrill.

Article IV.—Fluctuation.

In chronic copious pericardial effusions fluctuation may sometimes be felt, or even seen : an observation as old as Senac.[1]

SECTION III.

LARGE VESSELS.

The impulses and thrills produced in the large bloodvessels will be considered in the chapters on Thoracic Aneurysms.

[1] Traité de la structure du cœur, de son action, et de ses maladies. 2nd edit. vol. ii. p. 364. Paris, 1783. In Senac's patient, the fluctuation occurred during palpitations, in the third, fourth, and fifth interspaces.

Also Wintrich : Einleitung zur Darstellung der Krankheiten der Respirationsorgane. Virchow's Handbuch der spec. Path. und Ther. vol. v. part i. p. 65. 1854.

CHAPTER IV.

PERCUSSION.

SECTION I.

INTRODUCTORY.

ARTICLE I.—HISTORICAL.

PERCUSSION, or the art of striking a part of the body so as to beget a sound useful for the discovery of disease, has been practised from the earliest times. Employed at first in the diagnosis of abdominal diseases (to distinguish tympanites from ascites[1]), it was not until the middle of the last century that percussion was applied to the discrimination of the diseases of the chest. This important extension of the powers of percussion we owe to Auenbrugger, who in 1761 published a small book descriptive

[1] This most ancient means of diagnosis is probably at least as early as Hippocrates. During the three busy centuries after Hippocrates, the Greeks invented the word tympanites, which was in familiar use by the time of Celsus.

of his method.[1] When we hear of the reception which Auenbrugger's contemporaries in the city of Vienna gave to his discovery it is difficult to restrain a feeling of anger. The medical dictators of the day, Van Swieten and De Haen,[2] disregarded percussion altogether: less exalted personages carelessly confounded it with the Hippocratic method of succussion. Auenbrugger tells us that he was prepared to meet with envy, hatred, and calumny; we know that he did meet with what is harder to bear, simple neglect: however the scanty records of the man's life justify the belief that he passed from one social deed to another social deed, and found his happiness in doing so.[3] It was worthy of Stoll that he at least should not fail to acknowledge the

[1] Leopoldi Auenbrugger, M.D., Inventum novum ex percussione thoracis humani ut signo abstrusos interni pectoris morbos detegendi. Vindobonæ, 1761. This edition is very rare: a reprint was published at Graz in 1867. The second edition, of 1763, is more common.

[2] De Haen himself has suffered in a similar manner. The admirable papers, which appeared from time to time in the Ratio Medendi, upon the use of the thermometer in medicine, were forgotten for eighty years; and the leading facts of clinical thermometry, well known to De Haen, have been rediscovered in our own day.

[3] Leopold Auenbrugger, der Erfinder der Percussion des Brustkorbes, und sein Inventum Novum: von Prof. Dr. Clar. Graz, 1867.

value of percussion ;[1] but it was Corvisart who, guided by his favourite author, Stoll, may be said to have discovered Auenbrugger. For twenty years Corvisart practised percussion at the Charité of Paris, and finally, in 1808, he published a translation of the Inventum Novum.[2] Henceforth the importance of percussion was undisputed.

The principles of the Inventum Novum are two: first, that the sounds produced by percussion must be regarded simply as acoustic phænomena, and named accordingly; secondly, the sounds are to be explained by reference to corresponding physical states, that is to say, to the presence or absence of air in the part percussed.[3] Auenbrugger's doctrines remained unassailed until Piorry, in 1826,[4] sought to establish a new theory, founded upon the principle that every organ yields to percussion a peculiar

[1] Stoll: Prælectiones in diversos morbos chronicos. vol. i. p. 86. 1788.

[2] Nouvelle méthode pour reconnaître les maladies internes de la poitrine, par la percussion de cette cavité, par Avenbrugger, ouvrage traduit du latin et commenté par J. N. Corvisart. Paris, 1808.

[3] Auenbrugger: §§ 17, 18, scholia.

[4] Paper read before the Parisian Academy of Medicine in that year.

sound. Hence a series of typical sounds: femoral, jecoral, cardial, pulmonal, intestinal, stomacal, osteal, humoral, and hydatid.[1] This scheme, however, is now discarded by its author, who has proposed another in its stead: we will not forget that Piorry invented the pleximeter. In 1839, Skoda[2] published his theory, based upon two principles: "we must first determine every possible variety of percussion-sound, and ascertain the conditions on which each variety depends; and then endeavour to reconcile our observations with the well-ascertained laws of sound."[3] Wherefore, in the first place, Skoda restores Auenbrugger's principle of nomenclature, and distinguishes percussion-sounds according as they are full or leer, clear or dull, tympanitic or not tympanitic, high or low; epithets which will be explained hereafter. In the next place, Skoda developes Auenbrugger's second principle by maintaining that "the dif-

[1] De la percussion médiate et des signes obtenus à l'aide de ce nouveau moyen d' exploration, dans les maladies des organes thoraciques et abdominaux. Paris, 1828. Page 33.

[2] Abhandlung über Perkussion und Auskultation. Wien, 1839. This work reached a sixth edition in 1864. A translation of the fourth edition, by Dr. Markham, was published in 1853.

[3] Skoda: Markham's trans., p. 4.

ferent sounds, which percussion produces over the regions of the liver, the spleen, the heart, the lungs, and the stomach, do not depend upon any peculiarities in these organs, but upon variations in the quantity, distribution, and tension of the air, present in the regions in which they lie, and upon the force of the percussion stroke."[1] The doctrines of Auenbrugger are in essence the doctrines of the present day.

Article II.—Method of Percussion.

i. Immediate Percussion.—This was the method employed by Auenbrugger, and may be described in his own words: "Let the chest be percussed by the tips of the fingers drawn together side by side and stretched out straight; let the chest be covered by a vesture, or the hand by a glove (not of smooth leather), for if the naked chest be struck by the naked hand a smack ensues which hides the character of the sound we wish to produce."[2] Corvisart often percussed by the whole flat of the hand.[3] At the present day immediate percussion is per-

[1] Skoda: Markham's trans., p. 6.
[2] Inventum novum, §§ 4, 5.
[3] Nouvelle méthode, p. 18.

formed only upon the clavicles (they constituting pleximeters), or when the physician wishes to obtain a rough preliminary notion of the resonance of a considerable extent of the chest surface.

ii. MEDIATE PERCUSSION.—Auenbrugger's glove was obviously an approach to that mediate percussion which was first systematically practised by Piorry.[1] Piorry interposes a thin plate of ivory (pleximeter) between the chest and the percussing fingers; the fingers moreover he keeps half bent, so that percussion is made by their very tips, and not by their pulps, as in Auenbrugger's process. To substitute a hammer for the percussing fingers was not a great stretch of inventive genius: Laennec frequently percussed with his massive stethoscope: from time to time divers plessors have been contrived, which may be seen in the shops of surgical instrument makers. But a hammer possesses no real advantage, and a finger of the left hand forms a perfect pleximeter: whence it comes that few physicians employ either plessor or pleximeter, except for the purpose of demonstration before a large class.[2] When the fingers

[1] Percussion médiate, p. 14.

[2] Piorry. Traité de plessimétrisme et d'organographisme;

are used to percuss with, it is necessary that the movement of the hand should proceed from the wrist and not from the elbow or shoulder, a nicety in manipulation which is acquired by practice.

By Gerhardt[1] resonators and sensitive flames, by Wintrich and Baas,[2] tuning forks have been applied to the physical examination of the chest. I must refer the reader to the works named below for further details on these topics.

Article III.—Theory of Percussion.

The first object of percussion is to discover what kind of sound is emitted by the part per-

anatomie des organes sains et malades, établie pendant la vie au moyen de la percussion médiate. Paris, 1866. Here the reader will find the argument stated in favour of the pleximeter.

Wintrich: Einleitung, p. 5. Here the cause of the hammer is pleaded.

[1] Lehrbuch der Auscultation und Percussion, mit besonderer Berücksichtigung der Inspection, Betastung, und Messung der Brust und des Unterleibes zu diagnostischen Zwecken. 3rd edit. Tübingen, 1876: pp. 81, 116, 161, 272.

[2] Wintrich: Einleitung: p. 44.

Baas: Phonometrische Untersuchungen der Brust und des Unterleibes. Deutsches Archiv für klinische Medicin, vol. xi. p. 9. 1872.

cussed. A secondary object is to discover the degree of resistence, or the density of the stricken spot.

¶ 1.—SOUND IN GENERAL.

All sounds own the common properties of loudness and duration: two other properties, namely, tone and pitch, are peculiar to some sound only.[1]

i. Loudness and Duration.—The loudness of a sound depends upon the length of its constituent waves. The duration of a sound depends upon the number of its constituent waves; that is to say, upon the time during which wave follows wave so closely as to be indistinguishable from each other by the ear, and to constitute a single sound.

ii. Tone and Pitch.—Both these properties regard the sound-waves in their relation to each other; that is to say, in their succession. The tone of a sound depends upon the order with which the waves follow on, upon their rhythmical succession, upon their exact repetition at regular periods, and with sufficient rapidity; it being

[1] Tyndall: Sound: a course of eight lectures delivered at the Royal Institution of Great Britain. London, 1867, p. 69.

found by experiment that the number of waves must not be fewer than forty in a minute, otherwise they do not blend into a tone. The pitch of a sound depends upon the swiftness with which the periodic waves follow each other, upon the number of rhythmical shocks which happen in a given space of time: the swifter the succession, the higher the pitch.

iii. NOISE.—Sounds, which are wanting in tone, may, for the sake of distinction, be called Noises. Noises are of two kinds. They may consist of irregular successions of sound-waves, lacking the conditions of rhythm and rapidity which are essential to tone. Or they may consist of a number of tones, simultaneously produced, which do not harmonize, and which the ear cannot resolve or separate into the constituent parts.

iv. Tone is the musical quality; and pitch depends upon it. For a sound which is not a tone, and which does not consist of the regular and rapid succession of waves, cannot afford that definite number of shocks, within a given time, which constitutes pitch. Or, again, a sound made up of an indistinguishable number of inharmonious tones cannot possess a distinguishable pitch. There is also a relation

between pitch and duration which will now be understood; a tone, which consists of a certain number of sound-waves, is shorter in duration just as it is higher in pitch.

¶ II.—PERCUSSION-SOUNDS.

The first division of percussion-sounds depends on tone; its presence or its absence. Some sounds are tones and some are not; hence the main distinction. And also the most ancient distinction; whereof the appreciation was, as we have seen, the first step taken in the art of percussion: the difference between a tone and a noise being the difference between the percussion-sound of a tympanitic and an ascitic belly.

CLASS I.—PERCUSSION-TONES.

Percussion-tones are also called clear sounds or resonances, for reasons which will appear hereafter.

I shall consider these percussion-tones under the sundry headings of their four common properties just discussed, namely, their loudness, duration, pitch, and tone.

I. LOUDNESS.—Loudness is not a character of

much practical worth, depending as it does, not only upon the conditions of the sonorous material, but also upon the force of the percussion-stroke.

II. Duration.—Duration is a somewhat more important quality. The prime property assigned by Skoda[1] to a percussion-sound, its fulness or its leerness[2] (ideas adopted from Laennec[3]) is, in fact, a compound perception, made up chiefly by the duration of the sound. The duration of a tone depends mainly upon the elasticity, the swaying power of the sounding body.

III. Pitch.—Pitch is a very much more important quality. The many different degrees of pitch, distinguishable in percussion-tones, are reduced to three or four heads, which have received arbitrary names. So that we have a kind of scale of percussion-tones.

i. The lowest-pitched tones are called Tym-

[1] Markham's translation : p. 8.

[2] Skoda's word "leer" is translated by Markham "empty" : I formerly suggested "scanty." But, indeed, the word "leer" needs no translation, for it is English as well as German, and bears the same meaning in both tongues. I have often heard the word in country places. See Halliwell's Archaic Dictionary : Leer or Lear.

[3] Auscultation médiate : vol. i. p. 28.

panitic,[1] because they are usually yielded by a tympanitic belly.

ii. The somewhat more highly-pitched tones I have proposed to call Sub-tympanitic, thereby to keep up the traditions of Auenbrugger;[2] it is the note usually yielded by healthy lungs, in their natural state of distension; the Pulmonal note of Piorry.

iii. The still more highly-pitched tones are called Trachæal[3] or Tubular, being more or

[1] Skoda gives the word "tympanitic" wholly another meaning. So well as I can make out, tympanitic means, with him, the same thing as that which I call clearness of tone, or rather perfect clearness. A tone, which is muffled to any degree, is "not-tympanitic" with Skoda. Wintrich makes this complaint: "Ich muss offen gestehen, dass mir die Expositionen des Wiener Meisters über alle die genannten Schalldifferenzen ganz unklar geblieben sind, zumal wenn der Versuch gemacht wurde, sie mit den Gesetzen der Physik oder auch nur den praktischen Auffassungen der Musiker in Verbindung zu bringen." Einleitung, p. 39. French disciples of Skoda call his tympanitic note, le bruit skodique.

[2] Sonus, quem thorax edit, talis observatur, qualis in tympanis esse solet, dum panno vel alio tegmine ex lana crassiori facto, obtecta sunt. Inventum novum: § 2.

[3] C. J. B. Williams: Lectures on the physiology and diseases of the chest, including the principles of physical and general diagnosis. London Medical Gazette: vol. xxi. p. 918 (March 10, 1838), and vol. xxii. p. 8 (March 31, 1838).

less like the note yielded by the trachæa, when the mouth is a little open.

iv. The highest-pitched tones are called Osteal,[1] because they are yielded by the hard solid tissues, cartilage and bone.

IV. TONE.—Thus far I have treated of percussion-tones as if they were highly gifted with that property; but such is not the case. Indeed, they are seldom pure or clear; their musical quality is mostly impaired; the tone is obscured, muffled, or dulled. And there are all degrees of tone-dulling down to utter dulness, or a noise wholly bereft of tone. Wherefore percussion-sounds are said to be more or less clear, more or less dull. And here I would affirm that these words, clearness and dulness, relating to the degree or purity of tone, are not only hallowed by long usage, but also possess a strict scientific meaning.[2] We inherit them from Auenbrugger,[3] who, in a sentence of fourteen words, has summed up the acoustic pheno-

[1] Piorry: Percussion médiate, p. 31.

[2] Tyndall: Sound, p. 51, for example.

[3] Sonitus vel altior, vel profundior; vel clarior, vel obscurior, vel quandoque prope suffocatus deprehenditur. Inventum novum; § 10, scholium. Curiously misunderstood by Corvisart: Nouvelle méthode, pp. 30, 31.

mena of percussion. The sound is a tone, clear or muffled, even to complete privation; this is the first and great distinction. And next, the tone is of a pitch higher or lower. Upon these two hang the whole theory and practice of percussion.

CLASS II.—PERCUSSION-NOISES.

Concerning the noises of percussion, the sounds which are toneless or dull, there is but little further to say. They possess the qualities of loudness and duration; but these, in percussion, are lightly esteemed. Any other differences depend upon the degree of dulness, whether absolute or not; whether, in fact, some amount of tone is mingled with it or not.

CLASS III.—BY-SOUNDS OF PERCUSSION.

Certain by-sounds, commonly called metallic, sometimes accompany the sounds which have been described. Metallic sounds are two: metallic ring and cracked pot.

I. The Metallic Ring (empty bottle note, amphoric note) consists in an overtone[1] existing either apart and alone, or as a harmonic super-

[1] Tyndall: Sound, pp. 116 et seqq.

added to the fundamental tone, which itself may be either clear or muffled. Percussion of the stomach when distended with air will yield the metallic ring. Also fillipping the cheeks sharply, when they are blown out to a degree which may be learnt on trial.

II. The Cracked Pot sound (metallic chink, cracked metal sound) was discovered by Laennec.[1] It is a sort of metallic ring, which may be likened to the chinking of money, or to the sound produced by clasping the hands loosely together, and striking the back of one of them upon the knee. Percussion of the chest of a healthy screaming baby will often give a cracked-pot sound. A heavy blow, expiration,[2] and the mouth open, are mostly needful in bringing out the chink. Its causes are not always the same; they will be set forth hereafter.

¶ III.—PHYSICAL CONDITIONS OF PERCUSSION-SOUNDS.

The main qualities of sound, and their essential nature, have been discussed in foregoing

[1] Auscultation médiate : vol. i. pp. 100, 655.

[2] Cornil and Grancher. Comptes rendus des séances de la société de biologie : for 1873 : series v. vol. v. p. 51.

pages.[1] We have now to pass from sound in idea to sounds in fact; we have to search out the ways in which sonorous waves become modified by the different conditions of matter in which they take place. The physical conditions, or properties of matter, modifying sound, which meet us at the outset, and which we shall have continually to bear in mind as we go along, are two: Conduction and Reflection. But the topic becomes yet further defined; the only material or physical conditions which we have to examine are those which hold good in the human chest. In other words, we have to explain percussion-sounds in particular. And, inasmuch as the prime distinction between them lies in the presence or absence of tone, we will begin with the discussion of percussion-tones.

I. Percussion-Tones.—The only tones, with which percussion has to do, are those produced by the vibration of bone, cartilage, or stretched membrane.

The sound of percussed bone and cartilage (for instance, that yielded by percussing the shin with the tips of the fingers) partakes from the first of the nature of a tone.

But with stretched membrane the case is

[1] Refer to ¶ 1: Sound in General.

different. Percussed in open air, it yields no tone. Nor can it be made to do so, unless it vibrate over an air-containing cavity with smooth walls. Under these circumstances, the sound-waves, which the air conducts from the membrane, are stopped and reflected by the walls of the cavity. But reflection alone will not beget a tone, unless the reflection be rhythmical. And rhythmical reflection requires a certain fixed relation between the rate at which the membrane vibrates, and the length of the air-column beneath. Given these necessary conditions, then the vibrations of the membrane become rhythmically reinforced by reflection; and rhythmical vibration, if rapid enough, will yield a sound having all the characters before described as being proper to tone. The reinforcement or production of tone by rhythmical reflection is called Resonance.[1]

In the case, then, of a membrane stretched over a cavity containing air, when we strike the membrane we produce a flutter of the air contained in the cavity; and some pulse of this flutter, corresponding to the size of the cavity, according to the law just laid down, is raised by resonance to the dignity of a tone.[2] And this

[1] Tyndall: Sound, p. 172. [2] Tyndall: Sound, p. 178.

is the reason why the words tone and resonance, as applied to percussion-sounds, have come to mean the same thing; the only tones which percussion knows (those of bone and cartilage except) are produced by resonance.

The conditions at which we have now arrived are these: a sac containing air. Let us carry our analysis yet further, and begin by distinguishing between an air-containing sac wholly shut, and one partly open.

1stly. Sac completely closed. We will discuss, in order, the cavity containing air and the wall of the sac.

i. The Air-containing Cavity.—It must be large for it to yield a Tone. To speak with greater precision than this is unnecessary, and indeed impossible, because the tone depends on many conditions other than the mere size of the cavity. The Pitch of the tone, so far as the cavity alone is concerned, is low in direct proportion to the length of the air-column.

ii. The Sac-Wall.—All the qualities of the sound produced—clearness, loudness, and pitch—depend much more upon the sac-wall than upon the air-cavity. The sac-wall is indeed the sound-swayer,[1] determining what the sound shall

[1] Schallherrscher. Wintrich: Einleitung, p. 16.

be. Let us discuss the sound with regard, first, to its production, and next to its conduction.

a. The production of the sound.—*a.* i. Clearness of tone.—In order to yield tone, the sac-wall must be apt to vibrate rhythmically along with the contained air. In other words, a unison vibration, convibration, or consonance of the sac-wall is required to the production of tone. Mere reflection of the air-vibrations from the inner surface of the sac-wall is not enough; that is to say, mere resonance of the contained air is not enough, there must be also a consonance of the containing membrane. When we search into the conditions which favour or oppose the convibration of the sac-wall, we find that its elasticity is the chief of them. The tension of the wall is indeed a matter of some consequence; for the membrane must be flexible enough to vibrate rhythmically, and high tension opposes flexibility. This is a fact which may be demonstrated upon the cheeks—and which is often demonstrated for us by the membrana tympani,—a certain mean tension being needful to good vibration. But the elasticity of the sac-wall is a much more important condition than is the tension; loose and inelastic membrane cannot vibrate rhythmically. In sum: the

sac-walls must be flexible and vibratile enough for the column of air within to be able to bend them to its own vibration, and thereby to make them its own sounding-board and tuning-fork;[1] else a clear-toned resonance is impossible. When the sac-wall consonates imperfectly the tone is proportionally muffled; and of muffling there are all degrees up to absolute dulness. *a.* ii. Pitch.—Acoustics teach us that the pitch of the tone of a vibrating membrane varies with its tension, thickness, density, and the like. We find, in practice, that an air-containing sac often yields to percussion a high-pitched tone, which is not the fundamental or ground tone of the cavity; but which is probably an over-tone or harmonic of the actual or potential ground tone. Such seems to me to be the nature of the metallic or amphoric ring already described. The lower-pitched ground tone is often badly produced; it has not force enough to make the membrane vibrate rhythmically. To do this, greater force is necessary, and greater force means quicker vibration,[2] and quicker vibration means higher pitch. That is to say,

[1] Tyndall: Sound, p. 175.
[2] Tyndall: Sound, pp. 91, 179.

the overtone can cause the sac-wall to consonate, when the ground tone cannot.

β. The conduction of the sound.—Loudness.—Suppose that the unison-vibration of air and membrane has produced a tone, it has yet to be conducted to the outer air. And this transference from membrane to air causes a great loss in the loudness of the tone. Wherefore, when possible, we put our ear upon the membrane itself, and thereby do away with the condition which interferes with good conduction. But this is a matter to be discussed hereafter.[1]

To apply these doctrines to the percussion of the chest. Pneumothorax fulfils the conditions of a cavity, large, closed, and air-containing. The reader will easily understand why a muffled low-pitched tone is yielded to percussion, and a clear high-pitched metallic ring to percussion and auscultation combined.

2ndly. Sac partly open. We will discuss, in order, the cavity containing air and the wall of the sac.

i. The Air-containing Cavity.—A very much smaller cavity will, if partly open, suffice for the production of a percussion-tone, than is necessary in the case, just considered, of a closed

[1] See the Bell-sound.

sac. Yet as before, so now again, it is not possible to lay down the preeise dimensions needful. Wintrich found that a column of air, six lines in length, was the smallest which would yield to percussion a tone variable in pitch; provided that the sac be open at one end, and the ear be exactly over the opening.[1] The breadth of the air-column is another obvious element in the ease. Capillary columns of air afford no tone, whatever be their length.

ii. The Sae-Wall.—In this respeet also, the case of an open sac is very different from that of a closed sac. The main eondition lies not so much in the sac-wall as in the opening; the opening in the membrane, aud not the membrane itself, is the sound-swayer. We will here also discuss the sound with regard, first, to its production, and next to its eonduction.

a. The production of the sound.—*a.* i. Clearness of tone.—The tone prodneed is elear, because reflection from the inner surface of the sae-wall (resonance) is the chief eondition, and unison-vibration of the sae-wall (eonsonance) is a matter of small importance. The sae-wall is, as above said, no longer the sound-swayer.

[1] Einleitung, p. 16.

α. ii. Pitch.—The pitch of the tone is high in proportion to the size of the opening. This fact also may be demonstrated upon the mouth; by opening it wider and wider, while percussing the cheek, we can show that the wider the mouth of the sac, the higher the pitch of the tone produced. The opening can be made so wide that high-pitched tone passes into tonelessness.

β. The conduction of the sound.—The tone produced is conducted in two ways: through the opening, and through the sac-wall. *β.* i. Through the opening the tone is conducted without change. *β.* ii. Through the sac-wall the tone cannot be conducted without consonance. Now consonance depends, as already explained, upon certain conditions of flexibility and thickness. In proportion to the thickness of the membrane and its lack of flexibility, does the tone become muffled by conduction, even up to complete extinction or dulness. The loudness also is diminished. And the pitch is probably lowered as the sound-waves are retarded.

To apply these doctrines to the percussion of the chest. The lung consists of a multitude of open sacs and tubes. But the minute ve-

sicular elements of the lung, and the minutest bronchiola are, both singly and collectively, too small to resonate.[1] The pulmonary percussion-tone is produced in the middle-sized and largest bronchia. And the vesicular or spongy structure is nothing but an inert membrane, so far as concerns the production of tone. These doctrines, which were first set forth by Wintrich, must be well understood; they alone make it possible to explain the physical conditions of the percussion-sounds of the lungs in health and in disease.

Take a healthy lung, distended as it is when within the chest. Percussion produces a clear tone in the bronchia; which tone, however, is not heard through the open tubes, but through the surrounding spongy structures. Now they consonate very badly, when they are distended with air; probably because they consist of an incessant alternation of membrane and air. Hence

[1] Der tympanitischer Schall der Lunge kann nie als solcher in den Bläschen entstehen. Wintrich: Einleitung, p. 22.

I quite understand that this doctrine may be disputed, and cannot be experimentally proved. Yet I do not see how we can set forth any theory of percussion, which does not assume that the spongy structure of the lung has nothing to do with the production of sound.

the percussion-note of naturally distended lung is not clear, but muffled. Remove the conditions of defective conduction; let the distension of the lung cease, and the air-sacs and bronchiola fall in upon the larger, stiffer tubes: in other words, let the lung relax, and become such as it is when taken out of the chest; percussion now will give a tolerably clear tone. For the layer of spongy structure around the bronchia has become thinner, and also probably more apt to consonate by loss of tension; in short, a better conductor of the bronchial tones.

The conducting power of the minuter structures of the lung can be increased by other means than simple relaxation. Exudations, liquid or soft solid, partially replacing the air, have this effect, and cause the lung to yield to percussion a clearer tone than natural.

A knowledge of these facts is so very important, be their explanation what it may, that the student should demonstrate them for himself upon the dead body (of a child, if possible). Let him percuss the chest and note the pitch and clearness of the resonance; then let him remove one lung, and percuss it when it has become relaxed, and he will find that the note is

very much clearer than before, although the pitch is higher. Upon the other side of the chest another instructive experiment may be performed. Let the chest be percussed; then let a small trocar and cannula be passed into the pleura, and air be injected through the cannula, but so as not to distend the side in the least. It will be found that the percussion sound is not much changed from what it was before the chest was opened. Now let air be injected so as to distend the pleura gradually to the utmost; and it will be observed that the percussion-note gradually gains in duration and clearness of resonance up to a certain point, and falls in pitch.

Before leaving this subject I may remark that our search into the physical conditions of percussion-tones has taught us that neither the clearness nor the pitch of the tone depends merely on the quantity of air in the part percussed. In other words, the theory of percussion is not so simple as many deem it to be.

II. Percussion - Noises. — Privation of the conditions, which have been declared necessary to the production and conduction of percussion-tones, results in percussion-tonelessness, noise, or dulness. It will be readily understood that

the privation may affect the loudness, the duration, or the tone of the sound, or any combination of these qualities. On the other hand, with regard to the physical conditions, there may be no tone-producing material in the part percussed, or the tone produced may be badly conducted, or the percussion-blow may be badly conducted. But there would be no profit in working out the acoustics of this topic any further.

III. Metallic By-sounds.—The nature of the Metallic Ring has been already explained. I may add here that the following conditions also are believed to be necessary to the production of this by-sound; namely, that the cavity possess smooth curved walls, and that it be not less than two inches in diameter.[1]

It remains to say a few words upon the Cracked-Pot sound. Its physical conditions seem not to be always the same. i. One kind, that which percussion produces in screaming children, is believed by Wintrich[2] to take place in the glottis, when the quick and hard blow suddenly sends compressed air between the vocal cords,

[1] Six centimeters (nearly two inches and a half): Wintrich: Einleitung, p. 34. If the cavity communicate with a bronchus, the size may most likely be much less.

[2] Einleitung, p. 36.

whereby they are thrown into irregular vibrations. ii. In like manner, the cracked-pot sound which heavy percussion, upon yielding chests, produces in healthy lungs, during mere expiration, is probably glottidean. iii. Another kind is but a variety of the metallic ring, and is associated with it: being produced, in air-containing cavities not wholly closed, when percussion causes a sudden condensation of the air, and so jars the tone. The mouth of the cavity enables the pressure within and without to be quickly equalised. To shut the mouth and nose prevents the production of a cracked-pot sound: but the metallic ring remains.[1] iv. It is likely that the sudden rush of air, through the opening spoken of, is attended by a hiss which heightens the effect of the cracked-pot sound. v. A sound, practically indistinguishable from the cracked-pot sound, is that to which Piorry has given the name of "humoral,"[2] and which is said to be sometimes produced by percussion over cavities which contain both liquid and air. The sound in question is a sort of percussion-

[1] Walshe: A practical treatise on the diseases of the lungs, including the principles of physical diagnosis. 3rd edit. London, 1860, p. 80.

[2] Percussion médiate, p. 31.

rale, due to splashing of the liquid in the cavity. A bladder, holding both air and water, if strongly percussed just below the surface of the water, yields a humoral sound.[1]

¶ IV.—PERCUSSION RESISTENCE.

The sense of resistence felt by the percussing fingers is greater or less in proportion to the greater or less compressibility of the part percussed. Hence solids and liquids are very resistent; air-containing parts much less so. It is by means of this sign, that the person percussing learns more from his percussion than does a bystander. Corvisart first drew attention to this sign:[2] Piorry, working out the subject, has at last almost come to exalt the tactile sensations of percussion above the acoustic. But, apart from all exaggeration, there is no doubt that by the sense of resistence we can distinguish between certain states which agree in yielding absolute dulness to percussion. The great resistence of a liquid effusion, and the change which we so often perceive on passing from the heart to the liver, are examples of this truth.

[1] Wintrich: Einleitung, p. 38.

[2] Nouvelle méthode, p. 16.

Percussion Thrill. A peculiar quivering sensation, called by Piorry the hydatid thrill,[1] is sometimes produced by percussion. The finger feels as if it were repelled several times in succession by a sort of elastic resistence or fluctuation. Most likely the only physical conditions, needful to the production of this thrill, are a sac tightly full of thin liquid. No doubt these conditions are fulfilled by most hydatid cysts: but Skoda has shown that even a stomach, filled with water and hung up, will yield a thrill to percussion.[2]

Superficial and Deep Percussion. Before I proceed to apply these principles to the practice of the percussion of the chest in health and disease, it will be proper to say a few words upon what are called Superficial and Deep percussion. By progressively increasing the force of the blow from the gentlest tap to the hardest the patient can bear, we influence progressively deeper layers of the part percussed. For example: gentle percussion will elicit as clear a pulmonary note an inch or two below the right nipple as above the nipple; but hard heavy percussion will produce a tone which

[1] Son hydatique: Percussion médiate, p. 32.
[2] Markham's translation, p. 22.

is much less long and loud in the former than in the latter spot: the true explanation being this; not that deep percussion brings out hepatic dulness below the nipple; but that, while gentle percussion influences only a small depth of lung, which depth exists as well below the nipple as above it, deep percussion, influencing a much greater depth of lung, shows, by a marked difference in the length and loudness of the sounds, that the necessary thickness of lung does not exist over the liver, but does exist above it.

In like manner the direction of the blow modifies the sound produced: different parts being influenced according as the blow is quite perpendicular to the surface, or oblique, or nearly horizontal. As a rule the blow should be struck quite perpendicularly.

SECTION II.

PERCUSSION OF THE CHEST IN HEALTH.

The pulmonary, cardiac, and mediastinal regions must be separately considered.

Article I.—The Pulmonary Region.

¶ I.—PULMONARY RESONANCE AND RESISTENCE.

i. Typical.—Frequent experiment upon the healthy chest is the means by which to fix in

the mind an idea of the sound and resistence afforded by percussion of the pulmonary regions. When disease affects one side only we possess in the other side a standard of health to which we may refer: even when both lungs are affected, but one more than the other, comparison is still useful: wherefore, to contrast the same parts of the two sides of the chest becomes an important rule in the practice of percussion.

ii. SUB-TYPICAL.—But certain deviations from the type are compatible with a state of perfect health; deviations for the most part due to the thoracic walls. The sound produced by percussion over the sternum, clavicles, ribs, and scapular spines, partakes of the osteal character. Ossification of the cartilages produces the same effect. The greater the quantity of soft tissue, muscular or adipose, which covers the thorax, the greater the muffling of the sub-tympanitic resonance. Hence the percussion-note of the chest is clearer in front, and at the sides, than behind; clearer in thin persons than in fat; it is sometimes almost impossible to get any sound deserving the name of resonant by percussing the backs of fat flabby people. When the chest-walls arc yielding, heavy percussion of the front of the chest will produce the cracked-pot sound.

Wintrich[1] has shown that, during the long deep expiration which attends coughing or screaming, the chest of children becomes very much less resonant than natural; a fact which it is most important to remember. Any part of the chest-walls which is stiffly arched bears off the force of the percussion-blow from the underlying organs, and thus weakens more or less the impulse which we wish to impart to them.

¶ II.—EXTENT OF PULMONARY REGION.

The region which yields a pulmonary note extends from the very apex of the thorax on each side, as low as the sixth rib in front, the seventh at the sides, and the tenth or eleventh behind. But sundry viscera encroach upon these limits.

(i.) The Heart causes a certain extent of non-resonance in the anterior part of the chest; see next page. (ii.) The Liver can, by hard percussion, be detected on the right side, as high as the fifth or even the fourth intercostal space in front, and ninth or tenth rib behind. (iii.) The Spleen on the left half of the chest, below the sixth rib laterally, modifies the per-

[1] Einleitung, pp. 30, 56.

cussion sound. (iv.) The Stomach, especially when distended with gas, affords its own resonance to percussion of the lower part of the left side of the thorax, as high, it may be, as the fourth rib, in the lateral region.

Article II.—The Cardiac Region.

The extent of cardiac percussion dulness will differ according to the force used in percussion, whether slight or great. Gentle percussion detects dulness only where the heart is uncovered by lung; this is the area of superficial dulness. Stronger percussion detects the dulness of the heart where it lies behind the lung; this is the area of deep dulness. The difference depends, as before explained, upon the mass of lung influenced by percussion.

i. The Superficial area is roughly triangular in shape: the right side of the triangle being the midsternal line from the level of the fourth chondrosternal articulation downwards; the hypotenuse being a line drawn from the same articulation to a point immediately above the apex-beat; the base being a line drawn from immediately below the apex-beat to the point of meeting between the upper limit of liver dul-

ness and the midsternal line. The area of superficial dulness is much diminished by a deep inspiration; much increased by the patient lying upon the left side (the same position which displaces the impulse to the left); and not materially affected by the patient lying upon the right side.

ii. The Deep-seated area reaches upwards as high as the third rib (in children even as high as the second interspace); to the left about a finger's breadth to the left of the impulse; and to the right as far as a little beyond the right margin of the sternum. But, in truth, the right limit of cardiac dulness is not very trustworthy; the osteal and conducted pulmonary notes interfering much with the cardiac percussion-sound.

No doubt it is sometimes quite easy to be able to discover the lower margin of the heart by percussion: sometimes a heightening of pitch and increase of resistence are tolerably well marked on passing from the heart to the liver; sometimes there is a distinct band of faint resonance between the two organs; and sometimes, in passing from the hepatic to the cardiac region, one becomes sensible of a slight increase in the intensity of dulness, and a most distinct

increase in resistence; owing probably to comparative thinness of the left lobe of the liver, and its position over the stomach. When the heart and liver dulnesses pass indistinguishably into each other, we must be content with assuming the lower margin of the heart to correspond with a line drawn from a little below the apex-beat of the heart to the point of meeting between the right limit of cardiac dulness and the upper limit of hepatic dulness; bearing in mind how intimate is the connection between the heart and liver by means of the vena cava.

Article III.—The Mediastinal Region.

The contents of the mediastinum in the healthy state do not affect the percussion-note in any way.

SECTION III.

PERCUSSION OF THE CHEST IN DISEASE.

Article I.—The Pulmonary Region.

Auenbrugger's Dictum.—If, over the fore-described pulmonary region, there is not perceived the fore-described pulmonary sound; equal on both sides, the force of percussion being equal; we may predicate the existence of disease where

the sound is preternatural.[1] This is Auenbrugger's dictum, and comprises the whole theory of percussion.

¶ I.—PULMONARY PERCUSSION-SOUND.

The typical pulmonary note may be departed from by increase or diminution of its resonance. Hence two classes of unnatural sounds.

In the following passages it is assumed that the chest-walls are elastic and not too fat : in practice it must ever be borne in mind that the more the rigidity and fatness of the chest-walls are increased, the more is the resonance afforded by percussion of them diminished.

Class I.—Increased Resonances.

The resonance is increased by the tone becoming tympanitic or clear. The mass or duration of a pulmonary tone is increased when it becomes tympanitic.

1stly. Tympanitic Resonance, mostly muffled, seldom or never clear, occurs when the sonorous

[1] "Si igitur ex prædictis locis sonoris non percipitur sonus manifestus, utrique lateri æqualis, eidem percussionis intensitati conformis, morbosum quid in pectore latere significat." Inventum Novum. § 11.

column of air is greater than natural; a condition present in pneumothorax, and in some states of lung not easily specified.

2ndly. Clear Resonance, sub-tympanitic or trachæal, occurs when the conditions which muffle the pulmonary sound, are removed: provided that no new causes of tone-dulling are introduced. In other words, whatever relaxes the vesicular structure, unmuffles the pulmonary tone and makes it clear: whatever replaces the vesicular structure by cavity containing air, but not tightly distended thereby: and lastly, whatever enables the clear tones of the larger air-tubes to be conducted to the surface.

i. Relaxed lung, when in contact with the chest-wall, affords at that spot a clear subtympanitic or trachæal tone. *a.* The lung is relaxed as a whole by pleural effusions, and by tumours or enlarged organs without the lung. But, inasmuch as the relaxed lung under these circumstances cannot keep up its contact with the whole of its chest-wall, the extent of the clear percussion-note is small. *β.* The lung is relaxed in part around sharply-defined pulmonary consolidations. *γ.* The lung is relaxed interstitially by solid or liquid intimately mingled with air-containing tissue. Hence the

clear trachæal tones sometimes yielded by catarrh, œdema, congestion of the lung, pneumonia at its very outset or during resolution, phthisis and tubercle.

ii. Cavities, filled wholly or mainly with air; when at the surface of the lung, or, if deeply-seated, separated from the surface by dense solid tissue, may afford a clear subtympanitic or trachæal tone. Cavities surrounded by natural lung tissue do not much influence the percussion-sound. Sometimes the clear tone of a cavity is heard during expiration only; during inspiration, and still more, when the breath is held, the tone becomes muffled.[1] The pitch of a clear tone falls or rises, according as the mouth is open or shut, when the cavity communicates freely with the air-tubes; for reasons before explained.[2]

iii. Solid masses, coming to the surface, and closely connected with large air-tubes, sometimes yield a clear trachæal tone: pneumonia and pulmonary tumours may exemplify this fact. In this case also, the pitch varies with the state of the mouth.

[1] Wintrich: Einleitung, p. 31.

[2] See part ii. chap. 21 § i. ¶ iv.

Class II.—Diminished Resonances.

The resonance is diminished when the note becomes weaker and shorter, or more muffled. When absolute tonelessness is present, it is vain to draw (so far as the sound is concerned) any further distinctions. When a certain amount of tone is preserved, it is not only possible but useful to distinguish the degree of clearness and the height of pitch.

The following conditions are attended by diminution of pulmonary resonance :—

i. Extreme distension of the lung with air, for reasons before given. Hence we should never percuss a chest whilst the patient is coughing or holding his breath.

ii. Liquid and solid exudations into the lung which do more than relax it ; which, indeed, destroy the conditions of resonance. Catarrh, œdema, collapse, congestion, pneumonia, phthisis, often illustrate this fact : hæmorrhagic infarctus, cancerous, and other tumours more seldom.

iii. Liquid exudations into the pleura, whereby the lung is superficially condensed to a degree beyond relaxation, and moreover separated from

the chest-wall. Dense false membranes have much the same effect.

Class III.—Metallic By-sounds.

I. The Metallic Ring is almost always present in pneumothorax, whether occupying the whole pleural sac, or loculated. Enormous pulmonary cavities, containing air, may likewise afford this sign.

II. The sundry causes of the Cracked-Pot sound have been already set forth.

¶ II.—PULMONARY PERCUSSION RESISTENCE.

Whatever diminishes the elasticity of the part percussed, increases the sense of resistence to percussion. Wherefore massive consolidation of the lung, liquid pleural effusions, and extreme distension of lung or pleura with air, afford a feeling of resistence more or less increased.

¶ III.—EXTENT OF PULMONARY REGION.

Over the cardiac region, percussion is employed in order that we may learn whether the lung has shrunken away from the heart, or covers it, or whether the pleura contains air. In the diagnosis of adherent pleura, of phthisis, or of

emphysema of the left lung these signs become useful.

The discovery of the position of the diaphragm and mediastinum, and of contraction of the pulmonary apices, depends chiefly upon percussion. These important subjects will be discussed hereafter.

Article II.—The Cardiac Region.

I have just shown how diseases of the lungs or of the pleuræ influence the area of cardiac dulness; I will now proceed to the effects of disease of the heart itself. The area of dulness (superficial and deep) may be diminished or increased.

i. Area diminished.—This occurs in the very uncommon cases of pneumopericardium, clear resonance superseding the natural dulness: a cracked-pot sound (humoral perhaps) has even been heard in such cases. Atrophy of the heart does not materially affect the area of dulness.

ii. Area increased.—This occurs in enlargement of the heart, and in pericardial effusion: for the diagnosis between these conditions the reader is referred to the second part.

Moreover the area of dulness may be alto-

gether displaced, in consequence of displacement of the heart; a subject considered in the chapter upon inspection.

Article III.—The Mediastina.

Dilatation of the large vessels, aneurysms, and solid tumours in the mediastinum are sometimes the eause of more or less dulness to percussion where there should be resonance; as will be further shown in the second part.

CHAPTER V.

AUSCULTATION.

SECTION I.

INTRODUCTORY.

Article I.—Historical.

AUSCULTATION existed not before Laennec. True, a few passages are found in the writings of earlier physicians[1] which speak of

[1] The following are the chief notices of auscultation contained in authors older than Laennec :—

i. Leather sound of pleural friction, and sound of lung shock. Hippoc. de Morbis : ii. § 59 ; ibid. iii. § 7.

ii. Friction-rale ? Hippoc. de Morbis : ii. § 61. See Van Swieten : Comment. in Aphor. : 1219.

iii. Succussion-splash. Hippoc. de Morbis : i. §§ 6, 15 ; ii. § 47 ; iii. § 16. De Intern. Affect. § 23. Coacæ Prænot. 424. De Locis in Homine : § 14.

iv. Heart's sounds. Harvey : de Motu cordis et sanguinis, cap. v.

v. Pneumonic crepitation. Van Swieten : Comment. in Aphor. 826. Quarin : Methodus medend. inflamm. Vindob. 1774, p. 101.

vi. Respiration bruissante. Double : Séméïologie générale, vol. ii. p. 31. 1817.

vii. Sounds of foetal heart. Mayor : quoted by Laennec, ii. p. 459.

I refer to Littré's edition of Hippocrates.

sounds heard in the chest, but the observations remained mere curiosities, wholly without influence upon practical medicine. It is interesting to mark the dawning of the great discovery. Corvisart had studied the different forms of enlargement of the heart, and had endeavoured to distinguish between active and passive enlargement; to this end the character of the impulse was carefully observed. Bayle, a disciple of Corvisart, was in the habit of applying to the heart-region his ear rather than his hand,[1] inasmuch as a heaving impulse is more readily detected thereby, be the reason what it may. Laennec, Bayle's friend and fellow-student, adopted the same method. Laennec had undergone a fifteen years' training in the hospitals of Paris when, in 1816, he was consulted "by a young person who presented the general symptoms of disease of the heart, and in whom palpation and percussion gave no information, on account of the patient's fatness. Her age and sex forbade an examination of the kind just

[1] "I have found this method nowhere alluded to, and Bayle was the first whom I saw employ it, when we followed the practice of Corvisart together. The professor himself never put his head to the chest." Auscultation médiate, 2me édit., vol. i. p. 5.

mentioned (by putting the head to the chest), when I remembered a well-known acoustic fact, that if the ear be applied to one end of a plank, it is easy to hear a pin's scratching at the other.[1] I conceived the possibility of employing this property of matter in the present case. I took a quire of paper, I rolled it very tight, and applied one end of the roll to the præcordial region; then leaning my ear on the other end, I was surprised and pleased to hear the beating of the heart much more clearly than if I had applied my ear directly to the chest."[2] He had discovered auscultation. At the Hôpital Necker he explored the new world gained for science; and in 1818 he read a "Memoir upon Auscultation by divers acoustic instruments, employed as means of investigation in the diseases of the thoracic viscera, and especially in pulmonary Phthisis."

In 1819 he published the first edition of his book on Mediate Auscultation[3]; and, in 1826, the second.

[1] This remark would seem to imply that Laennec had put his head to the chest, in order "to hear the beating" of the heart: a phrase which he constantly uses: compare Auscultation médiate: vol. ii. pp. 385 sqq.

[2] Auscultation médiate: vol. i. p. 7.

[3] De l'Auscultation médiate ou traité du diagnostic des

Article II.—Methods of Auscultation.

It was by means of an instrument that Laennec was enabled to discover the powers of Auscultation. Since his day the stethoscope has been discarded by many persons, who, preferring immediate to mediate auscultation, apply the ear directly to the chest. And doubtless the sounds are heard loudest in this way ; they are weakened by conduction through a stethoscope. However the drawbacks to immediate auscultation are great, and chiefly these : the impossibility of listening to every patient's chest without the interposition of some kind of vestment, which, besides being a bad conductor of sound, gives rise to divers noises of its own ; the impossibility of applying the ear to every portion of the chest ; the impossibility of localising sounds with sufficient accuracy. Moreover, we must not take for granted that the ear, applied directly to the chest, will needs conduct the sounds more truly than will a stethoscope. Heart-sounds and

maladies des poumons et du cœur, fondé principalement sur ce nouveau moyen d'exploration. Paris, 1819. For title of second edition, see p. 52.

murmurs, in particular, often acquire, by immediate auscultation, a booming indistinct character, which does not belong to them. When this is the case, what we lose in mere loudness by using the stethoscope is well repaid by the greater definiteness of what we hear. No doubt a person may become a skilful auscultator who listens with his unassisted ear: but let mediate auscultation ever be considered the rule of practice, and immediate the exception; the physician making of the stethoscope, not a crutch, but a staff, which he uses when he has it, yet when he has it not he does not want it.

Stethoscopes are either hollow or solid. The hollow instrument conducts best; and the conduction is helped by the reflection which goes on in the hole, provided it be quite cylindrical throughout the greater part of the stethoscope. But sometimes this reflection is a drawback; sounds lose their definiteness and special character thereby; this is particularly the case with some heart-murmurs. When things are so, the solid stethoscope is useful: it may weaken the sounds spoken of, but it conducts them with much more sharpness and distinctness. Light wood or elastic metal is a good material for the

stethoscope. Now and then a flexible stethoscope is serviceable, that is to say, when we wish to auscult a bed-ridden patient who cannot well be raised.

Article III.—Murmurs in General.

A murmur is a sound produced by the flow of fluid, liquid or gaseous, along a tube. Fluid flowing, however swiftly, along a tube of equal caliber throughout, produces no sound. The condition necessary to the production of a murmur is a sudden change in the caliber of the tube.

I. Onward Murmur.—A jet of fluid flowing, swiftly enough, out of a narrow orifice into a wider space, is called a fluid vein.[1] The molecules of a fluid vein are agitated by movements which cause the vein to vibrate, and which are productive of sound. The loudness of the sound depends upon the swiftness of the flow: the quality of the fluid, or the size of the orifice are of import only inasmuch as they exert an influence upon the swiftness of the flow. The sound

[1] Félix Savart: Mémoire sur la constitution des veines liquides lancées par des orifices circulaires en mince paroi. Annales de chimie et de physique: 2nd series, vol. 53, p. 337. Paris, 1833.

is carried farthest in the direction of the flow, hence the name, onward murmur.[1]

II. Backward Murmur.—Fluid flowing, however swiftly, from a wider into a narrower space, produces no sound. But if the stream break, swiftly enough, upon a bevelled edge, like unto that of a whistle, the fluid becomes vibrating and sonorous. If the bevelled edge surround a considerable constriction within the tube, the sound is carried farthest in a direction against the flow of fluid: hence the name, backward murmur.[2]

III. Musical Murmurs.—Murmurs of either kind sometimes acquire the character of tones; these are called musical murmurs.

i. A musical murmur is usually due to the consonance of a solid, which plays the part of the reed or string in an instrument, and which is set in vibration by the sonorous fluid stream.

ii. A musical murmur is sometimes due to the vibration of the fluid vein alone; especially when the tube is curved so as to form a semicircle just beyond the constriction which causes the fluid vein.

[1] Chauveau: Études pratiques sur les murmures vasculaires ou bruits de souffle, et sur leur valeur séméïologique. Gazette médicale de Paris. 1858, pp. 247, et sqq.

[2] Bergeon: Des causes et du mécanisme du bruit de souffle, p. 25. Paris, 1868.

SECTION II.

AUSCULTATION OF THE LUNGS AND PLEURÆ.

Auscultation of the surface of the chest is practised with reference to three kinds of sounds: i. the Voice, as it is heard over the thorax: ii. the sounds of Breathing: and iii. the sounds produced in the Pleura.

Article I.—Thoracic Vocal Sounds.

The voice, as it is heard by auscultation, is usually called the Vocal Resonance: a phrase which we inherit from Laennec, and which involves a theory not yet discussed. It is useful to study the vocal resonance before the respiratory sounds; inasmuch as the origin of the sound is, in the former case, clear and indisputable, but, in the latter case, not so. Let us follow the historical order: the first fact which Laennec discovered by auscultation concerned the vocal resonance.

¶ I. THEORY OF VOCAL RESONANCE.

The prime distinction between the different kinds of vocal resonance lies in the degree of change (in respect of articulation) which the tone of the voice has undergone by the time it

reaches the surface of the chest. Whence two classes of vocal resonances; the muffled (or more changed), and the clear (or less changed). Clear vocal resonance, being usually heard over the large air-tubes, is also called bronchophony.

i. Muffled Vocal Resonance.—The naked ear, applied to the chest of a person who is speaking, perceives an indistinct humming or buzzing noise: the laryngeal tones have lost greatly in clearness, or articulateness. Their loudness also is much diminished: so that a weak voice is not heard at all.

ii. Clear Vocal Resonance, or Bronchophony.—What vocal resonances shall be deemed clear enough to form a class apart from the muffled vocal resonances is an arbitrary arrangement. The line is drawn at that amount of clearness which the voice possesses when listened to in the upper part of the interscapular regions, in a certain proportion of perfectly healthy persons. In some people we hear nothing different from what we hear over the rest of the chest; but in some we hear a vocal resonance which is comparatively clear, that is to say, which approaches more nearly in character to the articulate sounds heard over the larynx or pharynx. Bronchophony then I define to include the

clearest vocal resonance ever heard over the healthy chest, and all degrees of clearness greater than this. For disease somctimes affords thoracic vocal sounds which are far clearer than any heard in health; sounds which are not more muffled than those heard over the larynx. And, just as the least clear vocal resonance, which can be called bronchophonic, is that which is heard over the healthy bronchi; so does auscultation of the larynx afford a standard of the most clear vocal resonance. For it is seldom possible that the voice should be heard over the chest, in health or in disease, with greater loudness or clearness than over the larynx.

The clearness of vocal resonance is not dependent upon its loudness; the weakest sounds may be as strongly bronchophonic as the loudest; indeed the two characters of clearness and loudness are often opposed, so that the clearness of bronchophony is rendered indistinct by its loudness. When this is the case, we must seek to set aside the element of loudness: a consideration which leads us on to the topic of

Whispered Bronchophony. Now whispering is articulation pure and simple.[1] And the

[1] De même que la parole est la voix articulée, de même

bronchophony of whispering is often much more clear than that of the voice loud as usual. Sometimes bronchophony cannot be detected unless the patient whisper. And even with the whispered speech it can be shown that loudness of bronchophony confuses its clearness. Thus: whispering is expiratory; but let a person, who is whispering during inspiration, be ausculted over the trachæa; and it will seem as if the loudness of the inspiratory sound drowned the clearness of the bronchophony.

Pectoriloquy. The name which Laennec gave to that physical sign which was the subject of his earliest publication relative to auscultation. Pectoriloquy having been the first-fruits of his discovery, no wonder that he always clung with affection to the name and sign. Laennec meant by pectoriloquy, a very clear vocal resonance having two characters; first, the being conveyed, as it were, along the bore of the stethoscope to the ear of the observer: next, the being heard over a very small space of the chest.[1]

aussi le chuchotement est le souffle glottique expiratoire articulé. Beau : Traité (hereafter cited), p. 20.

[1] La pectoriloquie est parfaite quand, par la transmission évidente de la voix à travers le stéthoscope, par l'exacte circonscription du phénomène et de ceux que la toux, le

Loudness of the vocal resonance has nothing to do with pectoriloquy; a whisper may possess the two notes of apparent transmission and exact circumscription. But the distinction drawn by Laennec between pectoriloquy and bronchophony is unnecessary. Pectoriloquy is nothing but a very clear bronchophony. The desire of making pectoriloquy to be a sign pathognomonic of accidental cavity within the lung led Laennec to speak of perfect, imperfect, and doubtful pectoriloquy: now he himself confesses that he could not distinguish doubtful pectoriloquy from bronchophony. In short he wavered in his own definition; a fact known to his pupils.[1] But we need not imitate Laennec in blurring the meaning of the word: pectoriloquy, sharply defined as above, is a useful term.

Sniffing Bronchophony. In some conditions of lung, bronchophony acquires a remarkable sniffing character.

Ægophony. Another and somewhat similar kind of bronchophony is that which Laennec

râle et la respiration donnent en même temps, on ne peut, en aucune manière, la confondre avec la bronchophonie. Auscultation médiate, vol. i. p. 66.

[1] Harrison. Some remarks on pectoriloquy. London Medical Gazette, vol. xix. p. 457 (Dec. 24, 1836).

called ægophony, in order to indicate its likeness to the bleating of a goat. Still closer is the comparison which he makes between ægophony and the voice of Punch. Bleating bronchophony, in particular, is much better heard by the naked ear than with the stethoscope. Laennec's idea of ægophony also was confused by his desire to make the sign pathognomonic of pleural effusion. His own pupils could not follow him.[1] Nor will we; apart from a mistaken motive, we shall find ægophony to be a very definite physical sign, and also a very uncommon one.

Vocal resonances are mostly heard best by auscultation with the ear alone: sometimes indeed the stethoscope altogether fails to conduct them. The same is true of auscultation of a pitchpipe's sounds.

The vocal resonance, though useful chiefly as a confirmation of the notions acquired by auscultation of the respiratory sound, sometimes acquires an independent value. When a patient breathes so as to produce scarcely any sound, or breathes noisily, or otherwise unnaturally, then we call in the aid of the vocal resonance to

[1] Piorry: Percussion médiate, p. 84.

remove our difficulties. A kind of artificial vocal resonance is produced by causing the patient to sound a pitch-pipe, during auscultation.

¶ II.—PHYSICAL CONDITIONS OF VOCAL RESONANCE.

The vocal resonance has been defined to signify the voice as it is heard upon the surface of the chest. Wherefore two points demand examination: What is the voice? How does it reach the surface of the chest?

The larynx is a reed instrument which is capable of sounding a fundamental tone. In common speech, sundry minor or segmental tones, overtones, are produced along with the chief tone. The vocal chords may vary the pitch of the tone they produce, but no change in the quality (timbre, clangtint) of the sound can be effected in the larynx itself. That is to say, the larynx cannot articulate. The mouth however, by varying its shape, can be made to resound to any of the laryngeal tones; and it is to different admixtures of these tones, occurring in the mouth, that articulation is due.[1]

[1] Tyndall: Sound, pp. 197 sqq.

The next consideration concerns the manner in which the voice reaches the surface of the chest. The sonorous undulations generated within the glottis and articulated above it, pass upwards and downwards; and just as the pharyngeal vault, the nasal fossæ, and the mouth play the part of an arched roof, so does the trachæa that of a speaking-trumpet. The inner surface of the windpipe reflects the vocal vibrations which would otherwise diverge, and confines them in the tube, so that the voice is carried in all its fulness down the windpipe; and would be heard at the bifurcation of the trachæa, as well as in the mouth, were it not for two circumstances, namely, that the current of air is in a direction reverse to the propagation of the sound, and that the articulated tones have to pass through the narrow glottis. Hence two causes of change in the thoracic voice to begin with.

But the analogy of the speaking-trumpet ceases at the bifurcation of the trachæa. Clear vocal resonance is not heard, in healthy people, beyond the neighbourhood of the larger bronchi: natural bronchophony ceases there. We have now to consider the physical conditions of the lungs. First of all we must remember that they are kept in a state of permanent openness or

distension, which favours the conduction of sound along the air-columns within the tubes. But, on the other hand, the progressively increasing number of air-tubes renders the sound they conduct to any given spot progressively weaker: the voice is no longer confined within a single cylindrical tube, but is spread out and diffused by an enormous number of minute diverging tubes, having a total sectional area very much greater than that of the single tube whence they spring. Probably the diminishing rigidity of the walls of the bronchia diminishes their reflective power: probably the increasing surface of tissue exposed to the sonorous vibrations increases the conduction of those vibrations, by the tissues, away from the air-columns. Wherefore the voice, heard over the surface of the lungs, has lost both in clearness and loudness, is both weak and muffled.

But why is the bronchophony of the larger tubes not heard above the vesicular vocal resonances? Because the pulmonary tissue in its naturally distended state, consisting of an incessant alternation of air and membranous walls, is a bad conductor of sound, whether as to loudness or to clearness of tone: and the bronchophony must pass straight through the lung. It

is hardly necessary to prove that distended lung does conduct sound badly: percussion already has shown that it does so; and let a person who has any lingering doubts upon the point explain, why the heart-sounds are so much weakened by passage through emphysematous lung, and why, in many people, bronchophony ceases to be heard the instant the stethoscope passes from off the trachæa on to the pulmonary regions.

Accidental Bronchophony and Pectoriloquy.—Accidental bronchophony is the name given by Laennec[1] to the bronchophony which is heard at a spot where nothing beyond muffled vocal resonance would be heard in a healthy chest. Accidental bronchophony is due to increased conducting or reflecting power in the lung tissues.

i. Increased Conduction.—We have learned that the vocal resonance, heard at the surface of the lung, is muffled in consequence of having to pass through a badly conducting material, namely, the air vesicles and bronchiola. And the vesicular structure conducts the vocal resonances badly because it convibrates or consonates with them badly. Whatever increases its consonating power increases its conducting power.

[1] Auscultation médiate, vol. i. p. 65.

And the consonating power is increased by whatever increases the homogeneousness of the structure of the lung, or, in other words, by whatever makes the lung approach nearer to simple solid or to simple air. The former case only, that of solidification, will be discussed in this place : the latter case, of aerifaction, is complicated by conditions of reflection. Solidification includes collapse of the lung, exudations into it, and new growths. Simple collapse brings the larger bronchia nearer to the surface, and so promotes bronchophony. Such is not the case in exudative consolidations, yet they also increase the lung's conducting power. The note of a pitch-pipe, sounded between the lips, is heard much more clearly over pneumonic lung than over healthy lung.[1] A solid nodule, close to a large bronchium on the one side, and reaching the surface of the lung, has been known to conduct (perhaps to magnify) the bronchial voice so well as to render it deserving of the name of pectoriloquy.[2] A coincident pleural

[1] In the case of the horse, healthy lung tissue is a very bad conductor of sound, hepatised lung tissue is a good conductor of sound : according to Bondet and Chauveau, in a paper hereafter cited.

[2] Walshe : Diseases of lungs, p. 147.

effusion brings in a new element of heterogeneousness. The sonorous columns of air in the bronchia have to give up their vibrations to the condensed lung, which yields them in turn to the fluid contained in the pleural sac; from the fluid effusion they have to pass through the solid walls of the chest. Wherefore the bronchophony becomes weakened and muffled. Moreover, it sometimes becomes changed in quality by passage through the pleural fluid, that is to say, it becomes ægophonic or amphoric, according as the fluid is liquid or aërial.

ii. Increased Reflection.—The voice is conveyed along and within the air tubes, by constant reflection of its sound-waves. In the spongy structures reflection ceases, so far as the human ear is concerned. But if they be replaced by a cavity, not beneath the bronchia in reflecting power, bronchophony will take the place of a muffled vocal resonance. If the cavity be large, and its inner surface apt for reflection, the bronchophony acquires a prolonged hollow and reverberating character, which, when very well marked, goes towards making up the sign of Pectoriloquy, as before defined.

Accidental Bronchophony is oftentimes clearer than the natural bronchophony heard over the

vertebra prominens, sometimes clearer than the trachæophony heard just above the sternum, very seldom clearer than the laryngophony heard over the larynx, never clearer than the voice from the mouth.

Sniffing Bronchophony. — Concerning the physical conditions which give bronchophony a sniffing character, I cannot say much. Perhaps they consist in an admixture of whiffing or tubular expiratory sound with the conducted voice.

Ægophony. — Laennec believed that the smaller bronchia, especially those with walls bereft of cartilage, become flattened by a pleural effusion, so as to behave like the reed of a bassoon or hautboy. Thus the bronchial tree becomes a sort of wind instrument terminated by a multitude of reeds in which the vocal resonance quivers.[1] Wintrich believes that the ordinary nasal character in bronchophony is due to a strong vibration of the walls of bronchia so small that it is accompanied by actual collision of their opposed internal surfaces.[2] The vibrating column of air, broken incessantly, yet too rapidly

[1] Laennec: Auscultation médiate, vol. i. p. 79.

[2] I rather lean to the opinion that the articulated voice acquires its nasal quality in the pharyngeal vault, which we can auscult by a stethoscope placed just in front of the ear.

for the intervals to be distinguished by the ear, imparts a nasal sound. When the interruptions to the sound become sensible to the ear, they yield the bleating character. Ægophony, in short, is a higher degree of nasal bronchophony.[1] Stone believes that it is not the pure laryngeal fundamental tone of the voice which affords ægophony, but only the articulated over-tones, whether whispered or spoken aloud. A layer of fluid in the pleura, while it stops the larger and coarser vibrations of the ground-tone, lets pass the finer and closer undulations of the high harmonics.[2]

To conclude: excepting a few uncommon cases of pectoriloquy, it seems that resonance (in the strict acoustic sense) has nothing to do with the production of vocal resonances in health or disease; that in fact the phrase, vocal resonance, can be continued in use only with the distinct understanding that the word resonance is employed in a sense quite peculiar to the nomenclature of auscultation.

[1] Wintrich: Einleitung, pp. 119, 146 sqq.

[2] W. H. Stone: On ægophony; St Thomas' Hospital Reports, new series, vol. ii. p. 187. 1871.

¶ III.—VOCAL RESONANCE IN HEALTH.

The vocal resonance over the pulmonary regions is weak and muffled. Behind, opposite the trachæa and the bifurcation of the bronchi (over the upper dorsal spines), bronchophony is heard in a certain proportion of healthy persons: a circumstance probably accounted for by the fact that only solids intervene between the windpipe and the surface of the body at the spot indicated. Under the clavicles, near the sternum, the vocal resonance (especially on the right side, and in women) is often bronchophonic: the right bronchus is larger and lies higher than the left. The voice is more sonorous in some persons than in others: it is, in women and children, oftentimes inaudible over a large portion of the chest.

¶ IV.—VOCAL RESONANCE IN DISEASE.

1. Increased Clearness of Resonance: Accidental Bronchophony.—i. Whatever increases the conducting power of the spongy structure of the lung increases the clearness of the vocal resonance. It has been already shown that the conducting power of the lung is increased by whatever diminishes the heterogeneity of its

structure. Diminution of the quantity of air contained in a part of the lung, diminution of the number of the alveolar septa ; either of these changes will be attended by increased homogeneity. For these reasons it will be apparent why consolidation of the lung and cavity are the two chief causes of bronchophony. Consolidation of the lung includes simple collapse, hæmorrhagic infarctus, pneumonia, phthisis, tubercle, and cancer. Cavities are due to phthisis, dilatation of the bronchi, or great emphysema.

ii. Cavity, however, often introduces a new element into the case, namely, increased reflection. Whence the bronchophony becomes, not only well conducted, but also prolonged, and "reverbs a hollowness."

iii. Collapse of the lung, attended by bronchophony, will be extensive enough to include large open air-tubes. And this is seldom the case, unless the collapse be due to pleural effusion, liquid or aërial. So that the pulmonary vocal resonance, whether bronchophonic or not, becomes subject to conditions imposed upon it by the divers kinds of pleural effusion. For instance, bronchophony sometimes becomes ægophonic, sometimes amphoric. Yet simple

changes in the degree of loudness and clearness of the vocal resonance are more common, especially in the case of liquid effusion. The quantity of the effusion has much to do with the degree of vocal resonance: as a rule, the more copious the effusion, the weaker the chest-speech. Baccelli[1] believes he has proved that the quality also of the liquid effusions is an important condition; that is to say, they conduct whispered bronchophony ("aphonic pectoriloquy") more or less according as they are more or less homogeneous. Clear serum conducts well; pus little or not at all.

2. Diminished Clearness of Resonance is an unimportant sign, except it be known to have supervened upon resonance præternaturally clear. And, in such cases, the soniferous power of the bronchi is at fault, in consequence of collapse, or of obstruction by mucus, blood, or exudation.

3. Pectoriloquy was deemed by Laennec[2] to be the infallible sign of an accidental cavity

[1] Sulla trasmissione dei suoni attraverso i liquidi endopleurici di differente natura. Estratto dall' Archivio di medicina, chirurgia ed igiene: dispensa vii e viii. 1875.

[2] Auscultation médiate, vol. i. p. 66.

within the lung; and no doubt this is true as a general rule, but it is a rule to which there are exceptions. Small superficial consolidations, closely connected with large bronchia, may increase the vocal resonance by true consonance, after the manner of a sounding board, so as to yield perfect pectoriloquy: yet this is seldom the case. Laennec was right in believing that a lesion, which causes pectoriloquy, lies at the surface of the lung.

Sniffing bronchophony is heard oftenest in lobar pneumonia; seldom in simple collapse.

Ægophony was deemed by Laennec [1] to be the infallible sign of a thin layer of fluid in the pleural sac; and no doubt this is true as a general rule, but it is a rule to which there are exceptions. Landouzy [2] believes that false membranes on the pleura may cause perfect ægophony: yet this cannot be often the case.[3] On the whole, good bleating ægophony is an uncommon physical sign. The word is often abused by being given to mere bronchophony with a nasal twang.

[1] Auscultation médiate, vol. i. p. 72.

[2] De la valeur de l'égophonie dans la pleurésie. Archives gén. de Médecine, 1861, vol. ii. p. 669.

[3] Auscultation médiate, vol. i. p. 81.

Resonance of the Cough and Cry. In infants the thoracic resonance of the cry sometimes affords useful evidence of disease; for instance, the cry heard through hepatised lung is strongly bronchophonic. In like manner, the resonance of the cough sometimes acquires value when other signs are absent. Much of what has been said of the voice applies to the cough and cry.

Article II.—Respiratory Sounds.

¶ I. THEORY OF RESPIRATORY SOUNDS.

The fundamental division of respiratory sounds is the same as that of vocal resonances. The respiratory sound, which is heard over the larger air-tubes, differs, by the possession of a certain quality, from that which is heard over the spongy structure of the lung. Wherefore the former is called Bronchial, and the latter Vesicular breathing.

i. Vesicular Breathing.—The ear, applied to the breathing chest, detects a sound which may be defined by the negative property of not possessing the bronchial quality. Wherever breathing lung is in contact with the chest-wall, there we hear this sound. Its inspiratory portion has a duration equal to that of the inspiratory movement; the expiratory portion follows

after the shortest possible interval, has a duration only one-fourth or one-fifth of that of the inspiratory sound, and is much less loud than it.

The sound is loud in proportion to the rapidity and depth of the breathing. The louder the sound the greater becomes the relative duration of the expiratory portion; and for this reason; the expiration-sound being potentially equal in duration to the expiration-movement (although during the latter part of the movement the sound is inaudible by the sharpest ear), whatever quickens and deepens the expiration-movement makes the whole sound louder, and the audible sound longer. Sometimes the tranquil breathing of adults is unattended by expiratory sound. Sometimes, especially in fat middle-aged women, the breath sound can be hardly heard at all. Loud vesicular breathing was called Puerile by Laennec.[1]

Sometimes the inspiratory sound, instead of being continuous, is divided into three or four distinct parts: occasionally the expiratory sound likewise is duplicate: this is called jerking breathing: a sign of no practical importance.[2]

[1] Auscultation médiate, vol. i. pp. 49 et sqq.

[2] Roger: De la valeur séméïotique de la respiration saccadée. L'Union médicale. Oct. 5, 1861.

Sometimes the chest is felt to heave with inspiration before any sound is heard : this has been called deferred inspiration.

Sometimes the expiratory movement is prolonged in consequence of obstruction to expiration; when this is the case, the sound is prolonged also.

ii. Bronchial Breathing.—Bronchial breathing, like bronchophony, is heard about the seventh cervical, and three or four upper dorsal vertebræ in a great number of healthy persons : especially in those who are thin, in women, and in children.[1] Bronchial breathing is distinguished from vesicular breathing by the possession of a special quality of sound, which is best called hollow or reverberating.[2]

Potain ; Du bruit respiratoire saccadé, et des souffles extra-cardiaques. Revue mensuelle de méd. et de chir., vol. i. p. 81. 1877. Believes that jerking breathing, when not due to friction, or to irregular respiratory movements, is due to the action of the heart on the neighbouring lung.

[1] Laennec : Auscultation médiate, vol. i. pp. 55, 56.

Lippe : Die Grenzen des normalen Bronchialathmens. Deutsches Archiv. für klinische Medicin, ix. p. 535, 1872.

[2] Laennec : Auscultation médiate, vol i. p. 55. But as P. M. Latham says, "The sounds can only be learnt by the practice of listening to them. It is useless to describe them. They are simple perceptions of sense, which no words can make plainer than they are, when the ear has

The loudness of bronchial breathing is an unimportant property: the special quality is as well marked in respiratory sounds which are weak as in the loudest; nay, loudness of sound often proves an impediment to the detection of that quality which alone constitutes the note of bronchial breathing. The expiration is always audible, although usually less loud than the inspiration: yet expiration manifests the special quality more clearly than inspiration.[1]

Laennec[2] gave the name Cavernous to that kind of breathing which possesses the bronchial or hollow quality in a high degree.

Another kind of bronchial respiration, which has been named Tubular,[3] is characterised by a well-marked whiffing quality. Tubular breathing is most frequently heard over hepatised lung, and, when once heard, is not likely to be forgotten. It is closely allied to sniffing bronchophony.

once become familiar with them. I must leave you to be your own self-instructors, and recommend you to be constantly practising auscultation for the purpose." Diseases of the Heart: Lecture I.

[1] The differences noted in this sentence exist in the pharynx, a fact easily discovered by auscultation just in front of the ear.

[2] Auscultation médiate, vol. i. p. 57.

[3] The word tubular was first used by Laennec, with respect to the cough. Auscultation médiate, vol. i. p. 90.

By the name of souffle or puff, Laennec[1] designated a phænomenon analogous to pectoriloquy, and sometimes superadded to bronchial, cavernous, or tubular breathing. The air during inspiration seems to be drawn away from the ear of the observer, and during expiration to be puffed back again.

By the name of souffle voilé, or veiled puff, Laennec[2] designated a phænomenon which it has puzzled his successors to identify. It is a modification of the puff, he says, in which each vibration of voice, cough, or breathing seems to shake a sort of mobile veil placed between a lung cavity and the observer's ear. Skoda[3] believes that Laennec intended to represent the phænomenon which is observed when the respiratory murmur is indistinct at the commencement of inspiration, but suddenly becomes bronchial, and even bronchial blowing, as the inspiration advances. Skoda's veiled puff is not very uncommon.

1 Auscultation médiate, vol. i. p. 58.

2 Ibid. p. 59.

3 Markham's translation, p. 99. Seitz' metamorphosing breathing (Ueber ein neues Hohlengeräusch : Deutsches Archiv. für klin Med., vol. i. p. 292, 1866) seems to be a kind of veiled puff, in Skoda's sense.

¶ II.—PHYSICAL CONDITIONS OF RESPIRATORY SOUNDS.

The physical conditions of the vocal resonance, as already set forth, and those of the breathing sounds are very much alike. The main question, which we have now to treat, concerns the source of the breathing sounds; that is to say, the manner in which they are produced. Let the reader call to mind the fact that whispered sounds (in other words, sounds produced by respiration in the inactive glottis) are audible all over the chest, and he will then be more ready to agree that it is at least possible, not to say probable, that the ordinary unwhispered respiratory sounds are produced in the same place. I may as well at once declare that, for my own part, I hold to Beau's doctrine in this matter. The spirit of my book, not dialectic, but dogmatic, forbids that I should discuss this problem here. Enough for me to say that my opinion has not been formed rashly, and that I do not ask the reader rashly to adopt it.[1]

[1] Beau: Recherches sur la cause des bruits respiratoires perçus au moyen de l'auscultation. Archives gén. de Méd. Aug. 1834. Also, Traité experimental et clinique d'auscul-

Beau's theory is the following. The lungs in the chest are distended: the tubes are all open, apt for conduction and reflection. The passage of the breath, through the narrow glottis into wider spaces above and below, produces sonorous fluid veins inspiratory and expiratory. The nostrils, the mouth, and fauces partake in the production of the respiratory sound: however, for present purposes, it may be deemed to be wholly glottidean. Now this glottidean breathing murmur is conducted down the air-tubes just as the loud or whispered voice is carried. All that has been said concerning the conduction and reflection of vocal resonance applies to the respiratory sounds.

Bronchial breathing is the glottidean sound more or less reverberated in the larger bronchia.

tation appliquée a l'étude des maladies du poumon et du coeur, Paris, 1856.

Bondet: Etude sur la respiration; recherches physiologiques sur le mécanisme des bruits respiratoires. Gazette hebdomadaire, Dec. 4 and 25, 1863.

Bergeon: Théorie des bruits physiologiques de la respiration, Paris, 1869.

Bondet and Chauveau; Contribution á l'étude du mécanisme des bruits respiratoires normaux et anormaux. Revue mensuelle de médecine et chirurgie, vol. i. p. 161. 1877. They believe that much of vesicular breathing is produced in the air-sacs.

By the word reverberated, I mean maintained by reflection. Reverberation (retentissement) is not necessarily resonance; for resonance relates to tone, which the respiratory sounds can hardly be said to possess. Reverberation is not necessarily echo; for echo implies an interval between the original sound and that which follows it. Reverberation might be called a subintrant echo: anyhow, it is the note of bronchial breathing.

Vesicular breathing loses the reverberating hollow quality in consequence of the badly conducting material (the spongy textures of the lung) through which the sounds have to pass.

Puerile breathing implies louder sounds than usual produced in the glottis, and a very open state of lung. Cavernous breathing is bronchial breathing rendered more intense by the reverberation of a cavity. Tubular breathing is hard to explain; we do not know how it acquires its peculiar whiffing character. The puff merely shows that the seat of the bronchial breathing is near the surface. Skoda's veiled puff is most likely due to some obstruction in the tube, communicating with a cavity, being suddenly removed.

¶ III.—RESPIRATORY SOUNDS IN HEALTH.

The breath-sound is vesicular over the whole of the pulmonary regions: excepting that bronchial breathing is to be heard between the scapulæ in many persons; sometimes under the right clavicle also (especially in women); and sometimes, yet seldom, under the left. The loudness of the breathing sounds differs very much in different people. In children, the respiratory sound is loud or puerile; a fact to be explained by the frequency of their respiration, and by the thinness of their chest walls.

A crepitation due to collapse is sometimes heard, especially at the bases of the lungs, and at the beginning of an examination; a few deep breaths suffice for the removal of this rale, when it is not due to disease.

¶ IV.—RESPIRATORY SOUNDS IN DISEASE.

I. Weak respiration indicates weak production or conduction of the glottic murmur. Whatever obstructs the air passages within, whatever compresses them without, whatever interferes with the movements of the chest, will produce weak respiration; which, in other respects, may

be vesicular or may be bronchial. That form of weak breathing which has been called deferred inspiration, occurs especially in emphysema and in laryngeal obstruction.

II. Loud respiration indicates good production and conduction of the glottic murmur. When local and a consequence of disease, the breathing is often obstructed in some part of the lungs other than that where the loud respiration is heard.

III. Bronchial respiration, heard where naturally the breathing is vesicular, indicates obliteration of the damping spongy structure of the lung: obliteration which may be brought about in two ways:—

i. By collapse of the air-sacs, or by exudation into them, or by both processes combined. The pulmonary substance, thus rendered more homogeneous, is better fitted to convey the bronchial sounds to the surface. Pneumonic, phthisical tubercular, hæmorrhagic, cancerous consolidations; collapse, simple, congestive, or œdematous; and thickening of the bronchial tubes with condensed surrounding tissue; all produce this effect.

ii. By destruction of the air-sacs: whereby the vesicular structure is replaced by large

cavities capable of much reverberation. Phthisis, and dilatation of the bronchi, are the most frequent lesions belonging to this class.

Wherefore, in short, consolidations and cavities are the chief causes of bronchial breathing, as also of bronchophony.

iii. The case of consolidation, whether mere collapse or other, is sometimes complicated by a concurrent pleural effusion. Under these circumstances, much depends upon the state of the lung, much also upon the kind of the effusion. The sounds in the solid lung are more or less loudly bronchial. A liquid effusion, according to its conducting power, either simply weakens the bronchial breathing, or actually causes it to lose its bronchial quality so as to become more vesicular in character. An aërial effusion either weakens the sounds, or imparts to them an amphoric hum.

¶ V.—RALES.

The natural breath-sound having been described, and also the changes in that sound which are due to disease, I now come to Rales, or sounds which are produced within the lung by respiration, and which are wholly addi-

tional to the natural or morbid breath-sound. Rale, rhonehus, rattle; these words are synonymous. I shall retain the elassifieation adopted by Laennec, and also his nomenelature, because I believe that his distinetions are of praetieal value in diagnosis, and that his names are as good as any others.

Rales are of three kinds: crepitant, mucous, and sonorosibilant.

I.—Crepitant Rale. — A rale whieh has been well eompared to the sound produced by rubbing a loek of the hair between the fingers close to the ear.[1] Crepitation of this kind is seldom heard except during inspiration, sometimes throughout the whole of it, sometimes towards the end of it only. Pneumonia, collapse, and œdema of the lung, are the three conditions which afford a crepitant rale. Its oceurrence in collapsed lung, during a deep-drawn breath, affords, I believe, the key to the immediate physieal condition necessary to the produetion of erepitation in most eases; namely, the opening up of collapsed air-saes.[2] Dissemi-

[1] Williams: Lectures. London Med. Gazette, vol. xxi. p. 275 (Nov. 18, 1837); vol. xxii. p. 261 (May 12, 1838).

[2] Van Swieten: Comm. in Aphor. § 826. "Ingratus in pectore strepitus, qui fit a vesiculis pulmonum siccis hincque

nated collapse of single air-vesicles is an important item in the changes consequent upon pneumonia and pulmonary œdema, as any one who will inflate the uncut engorged or œdematous lung of a child may easily discover. Insufflation of the lung in such cases will bring out an immense number of air-sacs, which were before invisible because collapsed, and which collapse again directly the air is allowed to escape: the transparent, non-pigmented tissues of a child are particularly favourable for this experiment. In pneumonia as soon as the hepatisation becomes dense the collapse cannot be removed by any pressure of air. Sometimes, doubtless, crepitation is a very fine mucous rale.

II. Mucous. Rale.—This rale includes all the sounds which are due to the passage of air through mucus or other liquids contained in the air passages. The notion received is certainly, for the most part, that of bubbles bursting; sometimes the sound is crackling rather than bubbling in character. The mucous rale is subdivided into varieties, according to the following considerations:—

crepitantibus instar corii arefacti, dum inspirando extenduntur," vol. ii. p. 724. Lugd. Batav., 1745.

i. The apparent size of the bubbles: so small as to approach the crepitant rale (subcrepitant), so large as to deserve the name of gurgling, and all intermediate sizes.

ii. The clearness of the rale: the rale being sometimes more or less obscure,[1] on account of the weakness of the respiration; a deeper breath (when this is possible) bringing out a rale much more distinct.

iii. The reverberation of the rale: when this character is well marked, the rale is called cavernous.[2] Reverberating mucous rales indicate the same physical conditions as do reverberating (bronchial) breathing or voice.

III. Sonorous and Sibilant Rales.—These are rales which are more or less accurately described by such words as snoring, cooing, whistling, hissing; the low-pitched sounds being called sonorous (rhonchus), and the high-pitched, sibilant (sibilus). Sounds of this kind are due to local narrowing of the air-passages; most commonly by mucus, in which case a cough, which dislodges the mucus, removes the rale. Palpable vibration often concurs with these rales.

[1] Râle obscur: Laennec: Auscultation médiate, vol. i. p. 103.

[2] Laennec: Auscultation médiate, vol. i. p. 99.

IV. Doubtful Rales.—The respiratory sound is sometimes attended by sounds not comprehended in any species of rale hitherto described, and doubtful both as to situation and significance. I allude particularly to two kinds of sounds. First: sundry Creaking sounds, not seldom heard at the apices of the lungs, and possibly due to creaking of pleural adhesions, but possibly also produced in the tissue of the lung itself.[1] Secondly: the Dry crepitant rale with great bubbles, as Laennec[2] named a sound resembling that produced by inflating a dried bladder; and probably really due, as he supposed, to distension of the enlarged air-sacs of emphysematous lung; unless, indeed, it be nothing but crepitation due to expansion of collapsed air-sacs.

Article III.—Pleural Sounds.

The pleuræ in a state of health yield no sound.

[1] Bruit ou râle de froissement pulmonaire. Fournet: Recherches cliniques sur l'auscultation des organes respiratoires, vol. i. p. 172. Paris, 1839.

[2] Auscultation médiate, vol. i. pp. 106, 308, 343.

Louis: Recherches sur l'emphysème des poumons. Méms. de la soc. méd. d'observn. de Paris, vol. i. p. 215. 1838.

In diseases of the pleura sundry sounds are met with, which may be arranged in two classes; friction sounds, and sounds produced in large cavities.

¶ I.—FRICTION SOUNDS.

Any unevenness of opposed pleural surfaces, or any exudation or morbid tissue between them, tends to make a friction sound accompany the respiratory movements.

The discovery of friction sounds has been the most important addition to the practice of auscultation of the lungs, as it was left us by Laennec.[1] Not that he was altogether ignorant of these sounds. In the spring of 1824, Honoré, who had succeeded Laennec at the Hôpital Necker, having observed a peculiar sound in the chest of a patient, sent him for that reason to Laennec; who heard what he called "up and down rubbing," and considered it to be due to interlobular emphysema.[2] The real meaning of pleural friction was first made out by Reynaud.[3]

[1] I have elsewhere alluded to the fact that Hippocrates knew pleural friction-sounds.

[2] Auscultation médiate, vol. i. p. 115.

[3] Mémoire sur quelques faits et aperçus nouveaux, relatifs

The diagnosis of a friction sound depends upon a consideration of the following particulars :—

1st. The Character of the sound. This is sometimes quite peculiar, and special to pleural friction; giving a distinct notion, either of rubbing in any degree, between the lightest grazing and the harshest scraping : or of creaking comparable to the creaking of leather.

2nd. The Position of the sound. A friction sound is commonly heard over a small part of one side of the chest ; especially the lower half of the chest below the axilla, or about the angle of the scapula ; here the movements of the pleural surfaces upon each other are probably the freest. It is rare to hear friction sound on both sides of the chest at the same time.

3rd. The Time of the sound. A friction sound may accompany inspiration, or expiration, or both, or only a small portion of either, especially the very end of inspiration. So that friction sound is mostly of respiratory rhythm ; but occasionally pleural friction may be developed over the præcordial region by the action of the heart, in which case the rhythm is cardiac.

4th. Friction sound is mostly an insulated

à l'auscultation de la poitrine. Journal hebdomadaire de médicine, vol. v. p. 563, Dec. 26, 1829.

phænomenon, that is, is not accompanied by any unnatural quality of respiratory or vocal sound.

5th. Cough has no power of modifying or removing friction sounds.

The commonest cause of pleural friction is exuded lymph; organised false membranes, miliary tubercles, and mere extra-vascularity, may likewise cause a friction sound. Laennec believed (as has been said) that a friction sound was producible by interlobular emphysema, and probably he was not mistaken. Walshe is of the same opinion,[1] and W. T. Gairdner, in a case of vesicular emphysema without adhesions, heard a friction sound of "shuffling" character, and felt a distinct rubbing.[2]

Sound of Pulmonary Shock. Aran[3] has described, under this name, an excessively harsh friction sound, attended by palpable vibration, produced by cough, and due to the collision of lung and thoracic wall in certain cases of pleurisy complicated with pneumothorax.

[1] Diseases of the Lungs, p. 133. 1860.

[2] Clinical Medicine, p. 438. 1862.

[3] Sur un phénomène particulier et non encore décrit, produit par la toux dans l'hydropneumothorax. Arch. gén. de Méd., ser. v. vol. viii., Aug., 1856.

¶ II.—AMPHORIC SOUNDS:

Or, sounds produced in a large cavity, are four in number: two spontaneous, and two produced by the physician during examination: the former are amphoric hum, and metallic tinkling; the latter are the bell sound, and succussion splash. I describe these signs in this place because they are most common in the pleural cavity.

I. AMPHORIC HUM.—By Amphoric hum[1] is meant a metallic resonance, such as is produced by blowing, speaking, or coughing, into a large and empty glass bottle. An amphoric hum requires the existence of a large cavity containing air; and may accompany—

i. The respiratory sounds; when there is a wide fistulous opening between a pneumothorax and a large bronchus, so that the breath flows freely in and out: or when loud bronchial respiratory sounds pass through a large resounding cavity, and acquire amphoric quality.

ii. The voice, cough, and rales.

iii. The cardiac sounds heard through a pneu-

[1] Laennec: Auscultation médiate, vol. i. p. 111. Bourdonnement amphorique.

mothorax, phthisical cavity, or stomach distended with air.

ii. METALLIC TINKLING.—A sound compared by Laennec[1] to that which is produced in a metallic, glass, or porcelain cup when struck gently by a pin. Metallic tinkling is a single sound, which attends respiration, speaking, coughing, or even mere change in the position of the body. With respiration the sound is mostly intermittent, that is, not heard with each movement; with speaking, the sound is produced more constantly, especially if the patient speak slowly, with a period between each syllable; with coughing, the sound is tolerably constant. The sound is heard on one side only, and mostly heard best in the middle zone of the side; sometimes it is heard best at the apex, and is then of limited extent.

iii. BELL SOUND OR METALLIC RING.—This sign, well known to Laennec,[2] has been more particularly pointed out by Trousseau.[3] It is only

[1] Auscultation médiate, vol. i. p. 109.

[2] En auscultant á l'aide du stéthoscope, et percutant en même temps, on entend une résonnance semblable à celle d'un tonneau vide, et mêlée par moment de tintement. Auscultation médiate, vol. i. p. 111. See Wintrich also; Einleitung, pp. 26 and 35.

[3] Pneumothorax; nouveau signe physique pathognomo-

the metallic ring of percussion, heard by auscultation, that is to say, by putting the ear to a large air-containing cavity, whilst an assistant strikes the surface of the sac by means of a metallic pleximeter and hammer, for which purpose two coins answer very well. Under these conditions a clear ringing sound will be heard, of a different loudness and duration in different cases, and sometimes not much inferior to the chime of a small clock.

iv. Splashing Sound.—This most venerable physical sign was well known to Hippocrates.[1] When a large cavity contains both liquid and air, and the patient is shaken while the physician applies his ear to the chest, a splashing sound is heard. In fact the splash is often heard by the patient himself.

v. Physical Conditions of Amphoric Sounds.—I have now spoken of the last of a most interesting series of signs afforded by large resounding cavities. I have classed these signs under the head of pleural sounds, because it is in the pleura that the physical conditions necessary to their existence are most frequently met

nique de cette affection. He calls the sound "bruit d'airain." Gaz. des hôpitaux, Apr. 4, 1857.

[1] See page 99.

with. These necessary physical conditions are the following :—

i. A Large Cavity.—The conditions of the metallic ring have been already discussed in the chapter on percussion. The metallic tinkle may be heard, according to Kolisko,[1] in a cavity not larger than a pigeon's egg, provided that the cavity be connected with a large air-tube. The amphoric echo and the Hippocratic splash may occur in cavities of moderate size. The walls of the cavity must be smooth.

ii. The presence of Air in the Cavity.—The succussion splash demands the presence of liquid also. For the amphoric echo and bell sound, air alone suffices. Laennec supposed that metallic tinkling did not occur except both air and liquid were present in the cavity;[2] Skoda denies the necessity of liquid;[3] and no doubt he is right: the intensest amphoric echo of respiratory sounds, or of rales; the falling of a drop of liquid; the bursting of a bubble; and crackling friction sounds, pleural or pericardial;[4] all are possible causes of the metallic tinkle.

iii. A communication between the bronchi

[1] Skoda. Markham's translation, p. 135.

[2] Auscultation médiate, vol. i. p. 110.

[3] Markham's translation, p. 134.

[4] Beau: Auscultation, p. 192.

and the cavity is certainly not necessary to the production of any of the sounds.

From the foregoing principles it will be now clear, why the amphoric echo and metallic tinkle occur in large phthisical cavities, and in pneumothorax: why the bell sound is not heard except in pneumothorax: and why the splash may be produced in hydropneumothorax, in large phthisical, suppurative, and gangrenous cavities, and in hydropneumopericardium. The distended stomach sometimes affords the means of demonstrating all of the amphoric sounds: the colon will occasionally give a succussion splash and the bell sound.

Appendix to Section II.

In this place I will speak of sundry sounds which, although neither pulmonary nor pleural, are produced by the breathing movements.

1stly. Peritoneal Friction, produced between the liver and the diaphragm, may be heard all over the chest-walls on the right side.[1]

2ndly. Shoulder-Joint Friction; that is to say, a dry rubbing sound, mostly inspiratory, and heard in the supraspinous fossa, although

[1] Sibson: Medical Anatomy, column 44.

produced in the shoulder-joint. The sound is heard louder as the ear is brought nearer to the joint, and is heard loudest over the joint itself. Some positions of the arm stop the sound; some movements produce it.[1] Most likely other joints —costal, clavicular, sternal—sometimes yield a similar sound.

3rdly. Shoulder-Blade Friction, palpable and audible, due to friction of the scapula against the ribs, necrosed or not, has been described.

4thly. Muscular Rumbling is often heard during auscultation, but, being continuous, cannot be confounded with pulmonary or pleural sounds.

SECTION III.

AUSCULTATION OF THE HEART.

Laennec brought the auscultation of the lungs well nigh to perfection, but it was far otherwise with the auscultation of the heart. He confirmed the truth of Harvey's remark, that sound is produced by the action of the heart:[3] he

[1] Gowers: British Medical Journal, Nov. 18, 1876.

[2] Galvagni: Ueber das Scapularkrachen: Medizinische Jahrbücher herausggbn von der k. k. Gesellsch. der Aerzte. Wien, 1873, p. 274.

[3] Ita dum istis cordis motibus fit portionis sanguinis e

noted that this sound is double : he discovered the existence of murmurs, or uunatural sounds: but when he attempted to go further, and to explain the sounds and thė murmurs, he became lost in confusion; "seeking a way and straying from the way; not knowing how to find the open air but toiling desperately to find it out." He even went backward; specially by denying, in the second editiou of his work, what he had maintained in the first, that at least some thrills and some murmurs are associated with valvular obstruction.[1] Our knowledge has increased greatly since the days of Laennec; but I will leave any further historical details to be referred to in their proper places.

ARTICLE I.—HEART-SOUNDS IN HEALTH.

The ear, applied to the heart-region of a healthy persou, will perceive that, for each impulse of the heart felt, two sounds are heard. One sound accompanies the impulse, one sound follows it : wherefore the former is called the

venis in arterias traductio, pulsum fieri et exaudiri in pectore contingit. Opera omnia a collegio medicorum Londinensi edita. De motu cordis, cap. v. p. 34. 1766.

[1] Auscultation médiate. 2nd edit., vol. ii. p. 428. Compare 1st edit., vol. ii. p. 316.

first or systolic sound; the latter, the second or diastolic. The two sounds differ in character; the second being sharper and shorter than the first. The first sound is heard loudest over the fourth or fifth intercostal spaces, just within the left nipple line: the second, over the base of the heart, opposite the third costal cartilage.[1]

Concerning the loudness of the sounds:

i. Whatever weakens the heart weakens the sounds. And weakens the first sound especially: indeed, it sometimes becomes quite inaudible in patients suffering from great vital debility.

ii. But the loudness of the sounds, as we hear them, depends not only upon the state of the heart itself, but also upon the quantity of material interposed between the heart and the ear. Wherefore in very fat people, in pulmonary emphysema, and in pericardial effusion, the sounds are weak.

Article II.—Heart-Sounds in Disease.

Sounds, heard over the heart-region, and morbid in character, are of two kinds: murmurs

[1] For the current doctrines respecting the causes of the heart-sounds, refer to Kirkes' Handbook of Physiology, by W. M. Baker. 9th edit. p. 154, 1876.

and pericardial sounds. The discovery of murmurs was made by Laennec :[1] that of pericardial sounds seems to have been made by divers physicians about the same time, yet no doubt the earliest published reference to these sounds is found in a book written by Collin.[2]

¶ I.—MURMURS.

Any fundamental change in the character of a heart-sound, or any superadded sound heard over the heart-region, constitutes a murmur: pericardial sounds excepted. So that it comes to this: we fix an idea in our mind of the healthy heart-sounds: and when we hear a sound over the heart-region which does not tally with the idea, we say, this sound is either a murmur or a pericardial sound. The diagnosis between these two kinds of morbid sound will

[1] Auscultation médiate, 1st edit. vol. ii. p. 214.

[2] Des diverses méthodes d'exploration de la poitrine et de leur application au diagnostic de ses maladies, 1824. Pericardial sounds (called craquement de cuir neuf) are spoken of on pp. 64 and 115. Collin was Laennec's chef de clinique; but Laennec disbelieved in pericardial friction sound: Ausc. méd., 2nd edit. vol. ii. p. 446, 1826. P. M. Latham discovered this sign at St. Bartholomew's Hospital in 1826: see Hope: Treatise, 3rd edit. p. 72, 1839.

be considered under the head of pericardial sounds.

The physical conditions of murmur have been already explained. In health, the respective sizes of the orifices and the cavities of the heart are adjusted so that no sound is produced by the blood-currents. But whatever contracts an orifice, whatever dilates a cavity, whatever establishes an orifice or a cavity where naturally none should be, will disturb the even flow of blood, and produce vibration and a murmur.[1]

The prime division of murmurs, audible over the heart-region, is drawn between those which are referable to the heart itself, its walls, orifices, cavities, and contained blood; and those which are referable to the great vessels next the heart. Hence the distinction between cardiac and vascular murmurs.

Class I.—Cardiac Murmurs.

The physical conditions of murmur are fulfilled, in the case of the heart, at its orifices, and there only. At least we know little or nothing of cardiac murmurs generated elsewhere. Now

[1] Corrigan: Inquiry into the causes of the bruit de soufflet and frémissement cataire. Lancet, April 4, 1829.

the orifices of the heart are of two kinds, some are provided with valves, and some are not.

i. The Valvular Orifices.—Each valvular orifice both admits the blood and shuts it off; and, whether open or closed, may give rise to murmur. Murmur arises at an open orifice when its size is too small with respect to the cavity beyond: that is to say, the orifice is narrowed, or the cavity is dilated, or both these morbid states concur. Murmur arises at a closed orifice (or say rather, at an orifice which naturally should be closed), when it is not closed, but leaks, and allows the blood partly to pass back into the cavity whence it came. Murmurs produced at an open orifice, and in the natural current of the blood, are called onward, obstructive, or constrictive murmurs: murmurs produced at a closed orifice, and against the natural current of the blood, are called backward or regurgitant murmurs.

ii. The Non-valvular Orifices.—To wit, the orifices of the venae cavae, of the pulmonary veins, and the perforations of the auricular or ventricular septum found in congenital malformations, or established after birth. With respect to the venous orifices, there is reason to believe that they may give rise to murmur, when the

related auricle is greatly enlarged, and the rush of blood is strong.[1] With respect to perforations of the septa, further detail seems to be unnecessary in this place.

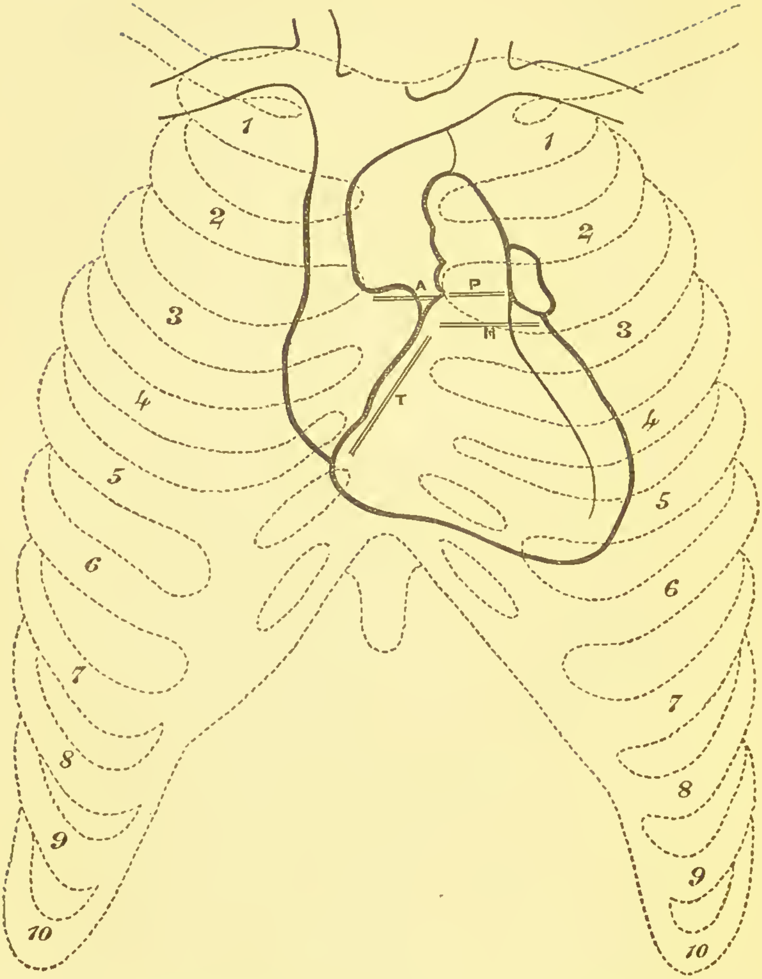
Murmurs were once characterised according to their acoustic qualities, whether blowing, filing, rasping, sawing ; but these are vain distinctions : in order to render murmurs serviceable in the diagnosis of disease we now regard only two things, their Place and Time.

I.—Place of Cardiac Murmurs.

Generally speaking, a murmur is heard best at that point of the surface of the body which is nearest to the orifice whereat the murmur is generated. So that it becomes important to study the relation which the orifices of the heart bear to the chest wall. The annexed diagram illustrates these facts. The Pulmonary orifice lies behind the second left interspace, close to the sternum : the Aortic orifice lies on the same level, behind the sternum : the Tricuspid orifice reaches from the sternal end of the third left intercostal space to that of the fifth right rib : the Mitral orifice lies on a level with

[1] See Markham's case, before cited.

Fig. 10.



POSITION OF HEART WITH REFERENCE TO CHEST-WALLS.

A = site of aortic valve. P = pulmonary.
M = mitral. T = tricuspid.

The direction of the rings, to which the bases of the aortic and mitral segments are attached, is obliquely upwards from right to left.

the upper border of the third left cartilage, close to the edge of the sternum, and slightly behind it. And let it be noted that the mitral orifice lies much more deeply than the rest.[1] But murmurs are not always conducted the shortest way to the surface. The conducting power of the tissues interposed between a valve and the chest-wall, and the direction of the blood current, have much to do with determining the point at which a murmur is heard loudest.

i. The influence of the superjacent tissues is well exemplified in the case of aortic and mitral murmurs. Both orifices of the left heart lie deep in the chest. The aorta becomes most superficial just above its valves, and is there almost in contact with a good conductor of sound, the sternum : wherefore aortic murmurs are well conducted up and down the sternum, and along the attached cartilages : so that, in fact, an aortic murmur is sometimes heard louder at the xiphoid cartilage than at the second intercostal space. The mitral orifice,

[1] Sibson (Position and form of the heart and great vessels : Reynolds' System of Medicine, vol. iv. p. 14, 1877) seems to differ from most anatomists in his doctrine concerning the position of the valves.

buried beneath heart and lung tissues, may be said to become practically most superficial where the cavity of the left ventricle becomes most superficial; that is to say, at or just above the apex-beat of the heart; and here, as a rule, mitral murmurs are heard loudest.

ii. The influence of the blood-current (or of convection, as it has been called[1]) is exemplified best in the case of aortic murmurs. Both obstructive and regurgitant aortic murmurs are well conveyed by the blood along the arteries, and regurgitating murmurs may be conveyed by the reflux of blood towards the apex of the left ventricle.

When the heart is displaced—that is to say, when the relation between its valves and certain points of the chest-wall is changed—the place of murmurs is likewise changed. This is not seldom the case in aortic regurgitation; to the chapter upon which disease refer.

[1] Salter: On cases illustrating the influence of convection in determining the seat of cardiac murmurs. Lancet, July 24–Aug. 14, 1869.

II.—Time of Cardiac Murmurs.

A complete cycle of the heart's action may be divided into four periods. i. The Auricular period: not attended in health by any sound: the auricles contracting.[1] ii. The Ventricular period: accompanied by the first sound: the ventricles contracting. iii. The Arterial period: attended by the second sound: the aorta and pulmonary artery contracting. iv. The period during which all parts of the heart are at rest. The subject requires a further development, thus:—

	Auricular Period.	Ventricular Period.	Arterial Period.	Rest.
Relative duration. Pulse=60.	$\frac{1}{10}$	$\frac{4}{10}$	$\frac{5}{10}$	
Valves: cuspid	open	shut.		
Valves: sigmoid		open	shut.	
Sounds		first.	second.	
Murmurs	præsystolic	systolic	diastolic.	

[1] Of late years, many physiologists, especially in Italy, have revived the old Galenical doctrine, that the ventricles dilate actively during their diastole, and so suck blood out of the auricles. See Revue des sciences médicales, vol. ix. p. 345, 1877. (De la diastole cardiaque, par A. Pitres.)

III.—Meaning of Cardiac Murmurs.

i. Systolic murmurs referable to the Auriculo-Ventricular orifices indicate reflux of blood : to the Arterial orifices indicate constriction at or just above the orifice, unevenness of the conus arteriosus, dilatation of the aorta, or perforation of the septum ventriculorum.

ii. Diastolic (and præsystolic) murmurs produced at the Cuspid orifices indicate constriction or obstruction of the orifice : at the Sigmoid orifices indicate reflux of blood, or dilatation of the vessel above the valve.

IV.—Loudness of Cardiac Murmurs.

i. Murmurs, audible in the horizontal posture, sometimes become much less loud and long in the erect ; nay, occasionally altogether cease. This is most frequently the case with præsystolic murmurs produced at the mitral orifice. The reason of the occurrence is not quite clear.[1]

ii. Pressure upon the heart region sometimes

[1] Ringer : On the influence of posture on endocardial murmurs. Edinburgh Med. Journal, vol. vi. p. 689.

Gowers : On the influence of posture on pracsystolic cardiac murmurs. Practitioner, Dec., 1873.

makes a murmur weaker. On the other hand, as has been shown by Latham[1] and Jenner,[2] pressure upon the upper part of the sternum or over the pulmonary artery will beget a systolic murmur in some young persons.

iii. The loudness of murmurs is sometimes under the influence of breathing; thus, a systolic apex murmur may be much louder during inspiration than during expiration.

iv. Murmurs are loudest sometimes when the heart beats forcibly, sometimes when it beats quietly; they are sometimes inaudible except at these respective times.

V.—Reduplication of Heart-Sounds.

A heart-sound is said to be reduplicated when, instead of being a single sound, it seems to be more or less doubled or repeated. Sometimes the sound is completely doubled; that is to say, in the place of one sound there are heard two sounds, with a distinct interval between them. But more often the reduplication is

[1] Diseases of Heart, vol. i. p. 62, 1846.

[2] On the influence of pressure in the production and modification of palpable vibrations and murmurs perceptible over the heart and great vessels, larynx, and lungs. Med. Times and Gaz., Mar. 1856.

incomplete, or subintrant; that is to say, before the first portion of the doubled sound is concluded, the second begins. Thus, if the single heart-sound be likened to the syllable tup, the reduplicated sound would answer to tup-tup (complete), or to turrup (incomplete).

I. Simple Reduplications. — Most reduplications seem indeed to be nothing more than repetitions of a natural heart-sound, first or second, as the case may be. The component elements of the sound are sundered more or less, and do not exactly concur in point of time. A reduplication of the second sound, for instance, is thought to be due to this want of keeping time happening with respect to the closure of the pulmonary and aortic sigmoids; the two second sounds are heard more or less apart from each other. The elements of the first sound being unknown, it is not safe to attempt an explanation of its reduplications. Potain,[1] however, has put forth a general theory of these simple reduplications, as follows. Intermittence is an almost constant character of reduplication, the sound being doubled with some beats of the heart, and not with others.

[1] Note sur les dédoublements normaux des bruits du cœur. L'Union Médicale, 1866, Nos. 97-115.

This intermittence is found to bear a close relation with the movements of respiration: so that the first sound doubles at the end of expiration and the beginning of inspiration; the second, at the end of inspiration and the beginning of expiration.[1] The reduplication is due to asynchronism in the closure of homologous valves, cuspid or sigmoid; and the asynchronism is due to difference in the amount of pressure exerted upon each set of valves; and the difference of pressure depends upon the different states of respiration.

II. Reduplication Murmurs.—If reduplications were all of this simple kind, the subject would hardly need much notice. But many seeming reduplications of a heart-sound are indeed murmurs; that is to say, a murmur is added to a heart-sound, or a murmur is split into two sounds, so as to simulate the simple reduplications.

i. False Reduplication of First Sound.—Potain describes a cantering action of the heart (bruit de galop) in which the first sound seems to be reduplicate; being preceded by a

[1] A fact already noted by Schafer: Ueber die Auscultation der normalen Herztöne, 1860. See Canstatt's Jahresbericht for 1859, vol. ii. p. 100.

weak præsystolic sound, which is well heard at the apex-beat only. He believes that the sign, whatever its nature may be, is in some way a symptom of granular kidneys.[1]

ii. False Reduplication of Second Sound.—Bouillaud was the first to describe a bruit de rappel, consisting of an apparent reduplication of the second sound, and occurring in mitral constriction. A præsystolic murmur also is usually present; whether this be so or not in a given case, the double sound is to be looked upon as being a divided diastolic murmur, and not a reduplicated second sound.[2]

Class II.—Vascular Murmurs.

i. A murmur, systolic, loudest in the aortic or pulmonary region, is often not due to any anatomical lesion discovered after death. Cachexia is the most common accompaniment of this murmur, and is indeed believed to be its cause. For cachexia implies a diminution of

[1] Potain: Du rhythme cardiaque appelé bruit de galop; de son mécanisme et de sa valeur séméïologique. L'Union médicale, vols. xx., xxi., 1875-6.

[2] Hilton Fagge: On the murmurs attendant upon mitral contraction. Guy's Hospital Reports, series 3, vol. xvi. p. 247, 1871.

the quantity of blood in the body; and diminished quantity of blood involves the following results:—i. The blood-channels adapt themselves to the anæmia: the capillaries, the small arteries and veins, the heart and its orifices become proportionally diminished in size: but the large arteries, being less contractile, are not proportionally diminished in size; that is to say, they become relatively dilated. ii. The diastolic pressure of blood upon the sigmoid valves is diminished: hence the systolic flow into the arteries meets with less resistence than natural, and so becomes relatively swifter.[1] Now these are the conditions of a murmur, as before explained.

ii. A murmur, diastolic, loudest in the aortic region, is sometimes associated with nothing more than rigidity and dilatation of the aorta: the valves being healthy. Refer to the chapter on Aortic Regurgitation.

iii. A murmur, diastolic, loudest in the pulmonary region, is sometimes due to openness of the ductus arteriosus.[2]

[1] Chauveau: Des bruits de souffle dans les anémies. Gazette médicale de Paris, 1858, pp. 340 et sqq.

[2] Hilton Fagge: A case of patent ductus arteriosus, attended with a peculiar diastolic murmur. Guy's Hospital Reports, series 3, vol. xviii. p. 23, 1873.

iv. A murmur, diastolic, loudest over the fourth left cartilage, is sometimes due to an opening formed between an aortic aneurysm and the pulmonary artery.[1]

¶ II.—PERICARDIAL SOUNDS.

No sound is produced by the movement of healthy pericardial surfaces upon each other.

In diseased states of the pericardium two kinds of sounds may be heard: friction sounds, and sounds due to the presence of air and liquid in the cavity.

I.—PERICARDIAL FRICTION.

It is convenient to consider pericardial friction sounds with reference to their diagnosis from endocardial sounds. The most important diagnostic characters of friction sounds are these:—

i. The special quality sometimes suffices for the diagnosis, being distinctly rubbing or scraping: but often enough this quality is ill-marked or absent. ii. Friction sounds are

[1] Wade: On a case of aortic aneurysm, in which a communication with the pulmonary artery was recognised during life by means of physical diagnosis. Medico-chirurgical Transactions, vol. xliv. p. 211, 1861.

mostly of limited extent, heard over a small portion only of the heart-region, especially at the base of the heart; they do not follow the laws laid down with regard to the points of greatest intensity, and the conduction of endocardial murmurs. Indeed there is no part of the heart-region where friction-sounds may not be heard loudest. But a very loud friction sound may be heard, not only all over the heart-region, but even all over the front of the chest, nay even at the angle of the scapula: though, in these latter cases, there is mostly marked and sudden weakening of the sound as soon as we pass away from its place of origin. iii. Friction sound is mostly both systolic and diastolic, being loudest in the systole; sometimes systolic only, or even diastolic only. A sound, which is at one time systolic and anon diastolic, is pericardial. A sound, which has no definite relationship with either of the heart-sounds, is probably pericardial. iv. Friction sounds are not intermittent like reduplications. v. The unchanged heart-sounds are sometimes heard through friction. vi. Friction sounds often give a notion of superficiality, be it explained as it may. vii. Palpable vibration sometimes attends them. viii. Their loudness is sometimes increased, sometimes de-

creased, by deep inspiration. ix. Their loudness is sometimes increased, sometimes decreased, by pressure. x. Friction sounds may be modified by change in the position of the body. Their place of greatest loudness may be thus made to change: this is very characteristic.[1] Friction sound sometimes disappears when the patient sits up, possibly on account of a small quantity of fluid which comes forward so as to separate the pericardial surfaces: but it has been shown that the same change in position sometimes removes endocardial murmurs. A friction sound, not to be heard otherwise, is sometimes produced when the patient lies upon his left side, whereby the position of the heart is much changed. A sound which shifts in place, from day to day, is pericardial.

Whatever roughens the pericardium can produce a friction sound: mere excessive vascularity, exudations, hæmorrhages, adhesions.

II. SPLASHING SOUND has been heard in hydropneumopericardium.

[1] Oppolzer: Vorlesungen über specielle Pathologie und Therapie, vol i. p. 26, 1866.

Appendix to Section III.

In this place I will speak of sounds which, although dependent upon the movement of the heart, are neither cardiac murmurs nor pericardiac friction sounds.

¶ I. Pulsatile Pulmonary Sounds, that is to say, pulmonary sounds produced or altered by the movement of the heart or of the great vessels.[1]

i. The respiratory sounds of healthy lung (that is to say, of the thin anterior edge of the left lung which lies upon the heart) may be so changed by the movements of the heart as to simulate its murmurs. The conditions of this change are not well understood: pleural adhesions, such as to fix the lung over the pericardium, are often present. The diagnosis lies, not in the quality of the sounds, but in the fact that they concur with a certain respiratory movement, as well as with a certain cardiac movement. They are mostly systolic and inspiratory;

[1] Laennec: Auscultation médiate, vol. ii. p. 446, describes altered breathing sounds and crepitation. See the later literature of the subject in Friedreich: Krankheiten des Herzens. 2nd edit. p. 89. Also, Landois: Graphische Untersuchungen, pp. 16, 29, 36.

less often diastolic, or expiratory. They usually cease to be produced when the breath is held.

ii. The respiratory sounds of a cavity (phthisical, bronchial, or pneumothoracic), may be altered by the movements of the heart or aorta in a similar manner. These false murmurs also are mostly inspiratory and systolic, or systolic and diastolic. The cavity is either close upon the heart and aorta, or is connected with them by a solid mass (such as solidified lung, or enlarged lymphatic glands), which is apt to convey the cardiac movements. In cases of phthisis, a strong aortic impulse can sometimes be felt where the false murmur is heard : for instance, in the third right intercostal space, close to the sternum.

iii. Rales also may be produced, and especially crepitation. It is systolic, and is most likely due to the entry of air into vesicles partly or wholly collapsed : the contraction of the heart causing a local inspiration in the portion of lung which lies upon the pericardium. The crepitation ceases to be produced when the breath is held after a deep expiration.

¶ II. Pulsatile Friction Sound generated in the pleura, of both respiratory and cardiac rhythm, sometimes is heard. Friction heard

behind or alongside the sternum, from the second to the sixth rib, is most likely pericardial. When a friction sound is heard at other parts of the heart-region, the diagnosis is not easy: pleural friction usually ceases when the breath is held, but this is not always the case; and there is good reason for believing that true pericardial friction may be occasionally stopped in that manner.

¶ III. By the name of Metallic Jingle, Laennec[1] meant the sound which is heard when the stethoscope is applied to the chest, whilst some bony part near by (such as the clavicle or spine) is percussed. When the palm of the hand is put over the ear, and the back of tho same hand is tapped, we hear a very loud metallic jingle. A sound of the same kind is sometimes heard when we listen to a heart which is beating forcibly: in this case, it is commonly supposed that the concussion of the ribs causes the sound. For my own part, I suspect that resonance of the meatus auditorius externus has much to do with the production of a metallic jingle.

Auscultation as applied to the large vessels of the mediastina will be treated of hereafter.

[1] Auscultation médiate, vol. i. p. 114, and vol. ii. p. 445; cliquetis métallique.

CHAPTER VI.

APPENDIX TO PART I.

SECTION I.

AUSCULTATION OF THE ARTERIES.

TWO kinds of sounds are heard by auscultation of arteries: conducted sounds, and murmurs produced in the part auscultated.

I. CONDUCTED SOUNDS.—The sounds of the heart, especially the second sound, are conducted along the arteries; not usually, however, farther than the carotids and subclavians. Yet, as hereafter mentioned, very shrill diastolic murmurs produced at the aortic orifice, may sometimes be heard so far away as the radials.

II. MURMURS PRODUCED IN THE SPOT AUSCULTED.—These are either spontaneous or factitious.

¶ I. Spontaneous Arterial Murmurs.—These are aneurysmal or subclavian.

i. Aneurysmal.—The systolic murmur which is sometimes produced in an aneurysm, is believed to be due to the formation of a fluid vein at the mouth of the aneurysm. The formation of a fluid vein requires that the cavity containing

fluid blood be considerably wider than the mouth of the sac, and that the blood current be swift enough.

ii. Subclavian.—A systolic murmur, seated in the subclavian artery, is often to be heard below the clavicles, mostly on the left side. The murmur is favoured by expiration, weakened or altogether removed by deep inspiration. To raise the arm to a right angle with the body weakens or removes the murmur. It is similar in character to that which is produced in other arteries by pressure, and is therefore presumed to be due to the same cause. But the anatomical condition which brings the sound about is unknown; adhesions at the apex of the lung have been suggested; because the murmur is more commonly met with in persons who are phthisical or predisposed to phthisis than in others.[1]

¶ II. Factitious Arterial Murmurs, due to compression of the artery by the stethoscope. These are systolic or diastolic.

[1] Richardson: On subclavian murmur. Clinical Essays, p. 1. London, 1861. Believes that compression of the artery by the subclavius muscle is a frequent cause of the murmur; which is therefore common in workmen whose work exercises that muscle: carpenters, upholsterers, and the like.

i. Systolic Murmur.—In healthy persons, a slight eompression of the larger arteries will generate a soft murmur, systolie with referenee to the left ventricle. In some forms of disease, notably in hypertophy of the left ventricle and in ehlorosis, firmer pressure makes the murmur harsh and whizzing. Moreover, under those eircumstanees, a murmur is producible in the smaller arteries; for example, in the plantar and the volar.

ii. Diastolie Murmur has long been known;[1] but Duroziez was the first to study it more partieularly.[2] It is heard in the femoral and axillary arteries, and attends a eertain degree only of pressure: a degree whieh must be learnt in eaeh case by varying the amount of foree used to eompress the vessel. A loud systolie murmur precedes the softer diastolic sound. It is often present when there is aortie regurgitation: in this case, it is supposed to be due to reflux of blood along the artery, during the ventricular

[1] Beau: Traité, pp. 375, 431.

[2] Duroziez: Du double souffle intermittent crural, comme signe de l'insuffisance aortique. Archives générales de médecine: series v., vol. xvii. 1861.

Bamberger: Ueber Doppelton und Doppelgeräusch in der Arteria cruralis. Deutsches Archiv für klin. Med., vol. xix. p. 437. 1877.

diastole: a reflux which the length and straightness of the femoral and axillary arteries are thought to favour. Yet a double femoral murmur is sometimes present when there is no reason to suspect valvular disease: this is especially the case in chronic poisoning with lead.[1]

SECTION II.

INSPECTION OF THE VEINS OF THE NECK.

That the jugular veins sometimes afford evidence of a dilated heart was known to Lancisi.[2] Of late years the whole subject of the physical signs to be seen and heard in the large veins has been submitted to very careful study.

[1] Duroziez: Des maladies organiques du cœur et de l'aorte et du double souffle crural, d'origine saturnine. Gazette des Hôpitaux: 1867, Nos. 146, 149, 150.

[2] Joh. M. Lancisii, De motu cordis et aneurysmatibus. Lugd. Bat. 1740. Propos. lvii. "Inquirere mechanicam rationem, ob quam in dilatationibus radicis Cavæ, Auriculæ, et Ventriculi dextri, ipsæ venæ Jugulares vicissim dilatentur, fluctuent, mirisque modis agitentur, et concidant." The cause is asserted to be a regurgitation of blood through the tricuspid valve. Lancisi refers to Hombert as having made the same observation in a paper published in the Proceedings of the Parisian Academy of Sciences in 1704.

In a healthy person, the internal jugular vein is not visible; the external jugular, on the contrary, is visible, if not in the erect position, at any rate, in the recumbent. The external jugular vein usually possesses two sets of valves, one at its mouth, and one in the middle of its course. The internal jugular is provided with valves at, or a little above, its mouth. All these valves are very uncertain both as to number and position: moreover they are often quite incompetent to close the vessel; this is especially the case with the valve in the internal jugular. The right internal jugular vein, right innominate vein, and vena cava superior, form a continuous channel which is almost straight. For this reason, all the signs about to be described are usually more marked on the right side of the neck, than on the left; and they would be always more marked in the internal than in the external jugular, were it not that the deep position of the former vein is a hindrance to inspection.

Inspection of the veins of the neck is directed to two points; the fulness of the veins, and the movements which the contained blood undergoes.

¶ I. THE FULNESS OF THE VEINS.

I have already said that, in health, the external jugular alone is visible, and even that vein, oftentimes, only in the lying posture. In disease, both veins are sometimes dilated to the size of a finger. I shall call an unnatural fulness of the veins, overfilling or distension of them.

Overfilling of the veins is either transitory or permanent.

i. Transitory overfilling accompanies powerful expiratory movements; which produce such an amount of pressure within the intrathoracic veins, that the valves at the mouths of the jugular veins are shut, and the blood flowing down from above cannot pass into the innominata. Inspiration reverses all this; the veins are emptied, and collapse. Repeated transitory overfilling of the veins is followed at last by permanent dilatation of them: a fact exemplified by patients who suffer from chronic pulmonary catarrh. If, in these persons, when the cough is quiet and the veins are invisible, we place our finger just above the clavicle so as to obstruct the external jugular vein, it at once swells up and manifests the amount of its dila-

tation; which may be taken as a mark of the degree to which the patient's tissues have suffered in consequence of his cough.

ii. Permanent overfilling of the jugulars is mostly due to overfilling of the right auricle; but, obviously, any obstruction to the upper vena cava, or to the innominata (by compression, thrombosis, or stricture) will have the same effect. When the original cause does not lie in the innominata, respiration affects the veins in the way above described, that is to say, they become more full during expiration, less full during inspiration. Permanent overfilling of the veins gradually causes them to dilate; the valves become incompetent.

¶ II. MOVEMENTS WITHIN THE VEINS.

Besides the respiratory movements which have just been described, the blood within the veins often undergoes movements which are associated with the contractions of the heart. Venous pulsations are præsystolic or systolic.

i. Præsystolic pulsation, according to Parrot,[1] can be seen in the jugular veins of a healthy

[1] Étude sur le siège, le mécanisme, et la valeur séméïologique des murmures vasculaires inorganiques de la région du cou. Archives gén. de Médicine, June, 1867, p. 649.

person, when he is lying down. The cause of the pulsation is supposed to be the contraction of the right auricle.[1] Be this as it may, when the veins are overfilled præsystolic pulsation is sometimes present, a fact proved by the sphygmograph. Whether the valves are competent or not makes no difference : when they are competent the impact of blood upon them from below is sufficient to agitate the blood contained in the veins above.

ii. Systolic pulsation in the veins is due to the ventricular systole, indirectly or directly. A direct systolic pulsation (venous pulse) signifies a reflux of blood out of the ventricle ; the tricuspid valve being incompetent. When the valve is competent, we may call the pulsation indirect. A systolic pulsation is sometimes visible during inspiration only.

a. Indirect systolic pulsation is mostly due to the fact that the tricuspid valve is raised, by the ventricular systole, into a sort of dome, convex towards the auricle. Hence an impulse backwards to the blood in the venous system ; counteracted however, unless the overfilling of

[1] But Luciani denies the reflux into the venæ cavæ during the auricular contraction. Hayem's Revue des Sciences Médicales, vol. ix. p. 347.

the veins be very great, by the diastole of the auricle. Friedreich suggests that in some cases the systolic filling of the aorta compresses the distended intrathoracic veins, and thus produces a movement in the jugulars.[1] The pulsations of the carotid artery often enough communicate systolic movements to the veins; but compression of the vein at the clavicle does not stop movements of this kind, and does stop movements transmitted upwards along the vein.

β. Direct systolic pulsation, being due to the propulsion of a wave of blood from the right ventricle into the jugular veins, requires that both tricuspid and venous valves be incompetent. It is easy to ascertain whether the venous valves are competent or not; namely, by compressing the veins in the upper part of the neck, and observing whether they are filled with blood from below or not. But it is not so easy to determine reflux through the tricuspid valve; that is, to distinguish positively between direct and indirect systolic pulsation. The difference is only one of degree. Both pulsation and filling from below are less marked when in-

[1] Die Krankheiten des Herzens, 2nd edit., p. 53. 1867. In Virchow's Handbuch der speciellen Pathologie und Therapie.

direct than when the tricuspid valve is incompetent. In the latter case blood is pumped out of the ventricle into the veins under strong pressure. To repeat: when the pulse is strong there is probably tricuspid regurgitation; when the pulse is weak it may be independent of reflux from the ventricle. When the pulse is very strong, it is sometimes palpable, or even thrilling.[1]

By Bamberger, Friedreich,[2] and others, the sphygmograph has been applied to jugular veins strongly pulsating. The venous pulse has thereby been found to be dicrotous; but dicrotous in a manner different from the arterial pulse. The venous dicrotism is anadicrotic, that is to say, it occurs in the rise of the blood-wave. The first or smaller impulse coincides with the auricular contraction; the second or chief impulse with the systole of the ventricles. Sometimes there is a katadicrotism, or diastolic dicrotism, at the very end of the fall of the pulse-wave: supposed

[1] In the case of rupture of an aortic aneurysm into the vena cava superior, systolic pulse and thrill are present in the veins of the neck.

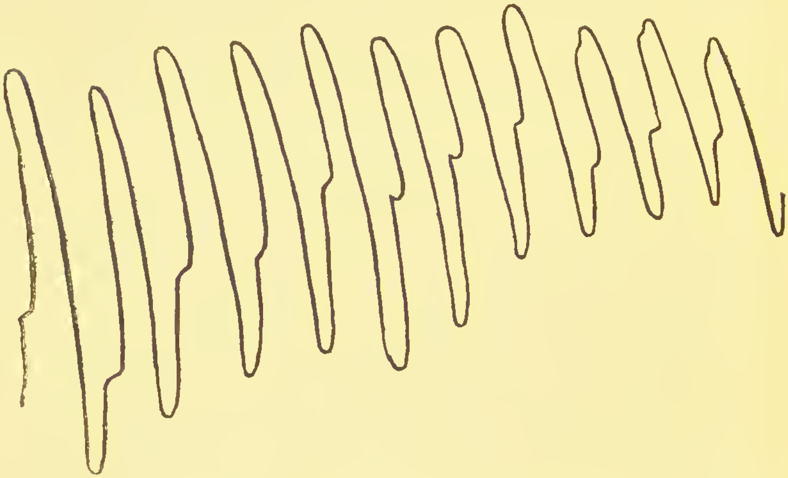
[2] Bamberger: Beobachtungen über den Venenpuls. Würzburger med. Zeitschrift, vol. iv. p. 232. 1863.

Friedreich: Ueber den Venenpuls. Deutsches Archiv für klin. Med., vol. i. p. 241. 1866.

to indicate repletion of the cavities of the right side of the heart, a sudden stop being put to the entry of more blood.

iii. Sudden collapse of the jugular veins,

Fig. 11.



Tracing of Anadicrotic Jugular Pulsation.

during the ventricular diastole, has been shown by Friedreich [1] to occur in some cases of pericardial adhesion. The sign, which is always preceded by systolic recession of the chest walls, consists in this, that the veins, full during the systole, suddenly collapse so as to become almost

[1] Zur Diagnose der Herzbeutel-verwachsungen: Virchow's Archiv, vol. 29, p. 296. 1864.

or quite invisible during the diastole. The supraclavicular regions sometimes sink at the

Fig. 12.

Tracing of anakatadicrotic Jugular Pulsation.

same time. Friedreich supposes that the diaphragm, drawn upwards by the adherent heart during the systole, and returning to its former position during the diastole, elongates the intrathoracic veins, and so sucks the blood out of the jugulars.

SECTION III.

AUSCULTATION OF THE VEINS.

I. The Veins of the Neck.—By means of a stethoscope, placed upon the side of the neck, there is often to be heard a humming sound; which was first referred to the veins by Ogier

Ward.[1] This venous hum is usually continuous; but other murmurs, which are intermittent, are occasionally heard in the veins.

¶ I. The Continuous Venous Hum, although especially well heard in chlorotic patients, occurs in a large number of healthy persons. Pressure with the stethoscope is doubtless a frequent cause of the murmur. But a venous hum, in chlorotic persons, is independent of pressure, and is believed to depend upon the anatomical relations of the parts concerned. The internal jugular vein is adherent, at its lower end, to the cervical fascia, in such a manner that, when the venous system shrinks in capacity and adapts itself to a lessened bulk of blood, the part of the vein spoken of cannot shrink, and so becomes relatively dilated: hence a sonorous fluid vein.[2] The more rapid the flow of blood the louder the hum: hence it is louder in the erect than in the lying posture; and is stopped by whatever produces stagnation of blood in the vein. Hence also, in most cases, although the murmur is continuous, yet it is subject to rhythmical increase of loudness; both during the inspiratory

[1] On the bruit du diable. Lond. Med. Gaz. 1837, p. 7.

[2] Chauveau: Des bruits de souffle, before cited.

draught of blood from out the veins; and during the ventricular systole, that is, during the auricular diastole, when the venous current begins again to flow freely.

¶ II. Intermitting Venous Murmurs of the neck are præsystolic, systolic, or diastolic. They all are heard better on the right side than on the left.

i. Præsystolic murmurs due to the passage of blood backwards through the mouth of the internal jugular vein, can be heard, according to Parrot,[1] in all persons when lying down.

ii. Systolic murmurs often exist at the root of the neck in cases of tricuspid regurgitation. Parrot declares that a double murmur, præsystolic and systolic, can be heard in such cases.

iii. Diastolic murmurs have been described, by Friedreich, as occurring occasionally in the internal jugular.[2] Hypertrophy of the heart, dilatation and strong pulsation of the aorta, and an anæmic state, are the conditions necessary to the presence of this murmur. It is supposed to be due to pressure of the aorta upon the vena cava or innominata, during the diastole.

[1] Étude, before cited.

[2] Die Krankheiten des Herzens, 2nd edit. p. 96.

The murmur has been heard in two cases only, one a case of aortic regurgitation, and the other of exophthalmic goitre.

II. Expiratory Murmur in Femoral Vein.—Incompetence of the valves at the top of the femoral vein may be detected thus. Evert the thigh, and place the finger, or the stethoscope, lightly upon the vein, just below Poupart's ligament. Then bid the patient cough, and each time he coughs, a marked thrill, and a murmur, will be perceived.[1] This lesion is thought to be a common cause of varix.

SECTION IV.

EPIGASTRIC PULSATION.

¶ I. The causes of epigastric pulsation are these: displacement of the heart to the right, the organ becoming vertical; pulsation of the abdominal aorta, or of the cœliac axis, or of an aneurysmal tumour, or of a tumour seated upon the abdominal aorta; regurgitation of blood into the hepatic veins, consequent upon dilatation of

[1] Beau: Traité, p. 416. 1856.

Friedreich: Insufficienz der Cruralvenenklappen. Berlin. klin. Wochenschrift. 1874, no. 48, p. 611.

the right side of the heart, a phænomenon first observed by Senac.

The possibility of an epigastric pulsation ever being directly due to the systole of the right ventricle is denied by Hamernjk and Friedreich.[1] However greatly the right ventricle be dilated, it never comes to lie behind the epigastrium. The epigastric pulsation of a dilated heart is no more than a movement conducted to the pit of the stomach from the real place of impulse. However, in these cases, the right ventricle does come nearer to the epigastrium than is natural, and may in fact lie so low as to beat against the xiphoid cartilage.

¶ II. Recession of the epigastrium, systolic, occasionally simulates pulsation, and when well marked is probably due to pericardial adhesions.

SECTION V.

THE POSITION OF THE DIAPHRAGM.

In many diseases of the chest, it becomes an important element in the diagnosis to ascertain the position of the diaphragm. Strictly speaking, we determine the lower limits of the lungs and heart, the upper limits of the liver, spleen,

[1] Krankheiten des Herzens, 2nd edit. p. 41.

and stomach, and deduce the position of the diaphragm from these data. For this purpose all the means of physical examination are more or less serviceable, but percussion is especially useful.[1]

¶ I. In Health.—By inspection, the position which the diaphragm held before puberty may be roughly determined (page 16). By palpation, the position of the heart's apex-beat, and the point where vocal vibration ceases, are ascertained. By percussion, the lung, at the end of an ordinary inspiration, is found to reach, in the sternal line the lower border of the sixth rib, in the nipple line the upper border of the seventh rib, in the axillary line the lower border of the seventh rib, in the scapular line the ninth rib, and in the spinal groove the eleventh rib. The lung, during quiet breathing, never fills the whole pleural cavity, but leaves it unoccupied at the part most distant from the bifurcation of the bronchi, namely, at the semicircular channel formed by the chest wall and the diaphragm where it shelves downwards to be attached to the ribs. This unoccupied portion of the pleural sac has been named the complemental space;

[1] Gerhardt: Der Stand des Diaphragmas: physikalisch-diagnostische Abhandlung. Tübingen, 1860.

there the costal and diaphragmatic pleuræ are in contact.

¶ II. In Disease.—The disease may be such as to afford an obvious impediment to physical diagnosis, by destroying the resonance of the parts above the diaphragm. Which is the case in solidification of the lower lobe of the lung, and in liquid pleural effusion. When the lung is solidified, vocal thrill, if present, will assist us, inasmuch as it fails rapidly beyond the pulmonary region. When liquid is present in the lower part of the pleura, it is impossible to do more than guess where the level of the diaphragm may be. The diaphragm lies high in:—contraction of the lung, distension of the abdomen, paralysis of the diaphragm. The diaphragm lies low in:—hypertrophous emphysema of the lungs, pleural effusions, hypertrophous dilatation of the heart, pericardial effusions, intrathoracic tumours, spasm of the diaphragm. A greatly enlarged heart or an abundant pericardial effusion may depress the diaphragm so much as to produce a tense swelling in the epigastrium: a fact known to Auenbrugger.[1] Depression of the right wing of the diaphragm sometimes depresses the right

[1] Inventum Novum, § 46.

lobe of the liver in such a manner that the left lobe is tilted upwards and raises the apex-beat of the heart.

SECTION VI.

THE POSITION OF THE MEDIASTINUM.

The position of the mediastinum is determined in the same manner as the position of the diaphragm, namely, by ascertaining the position of the organ which is most intimately connected with the mediastinum, that is the heart. By palpation we discover the position of the apex-beat of the heart: by percussion we are enabled to confirm the notions acquired by palpation, and to map out exactly the position assumed by the heart, auscultation likewise is serviceable to the same end. The mediastinum is displaced in unilateral pulmonary or pleural disease; and the displacement is either towards or away from the seat of disease. The mediastinum is displaced towards the seat of disease when one lung is shrunken: this is especially seen in phthisis, but also, to a less extent, in an adherent pleura. The mediastinum is displaced away from the seat of disease, in unilateral pleural effusions of liquid or gas. When

the effusion is liquid we possess an additional means of determining the position of the mediastinum, to wit, percussion of the sternal region above the heart. The upper part of the sternum naturally yields a clear resonance: under the pressure of a copious liquid effusion into either pleura, the mediastinum bulges so much towards the unaffected side, as to afford absolute dulness to percussion in the sternal region, and even somewhat beyond it. Intrathoracic tumours also displace the heart.

Dr. Powell[1] has shown that the displacement of the mediastinum, which takes place in unilateral pleural effusions, is not at first due to the pressure exerted by the effusion. The lungs, in health, are in a state of distension which is kept up simply by excess of atmospheric pressure from within; the thoracic walls bearing off the atmospheric pressure from without. The elasticity of the lung is continually striving to overcome this distension, as is manifested by the relaxation of the lung which ensues when the internal and external atmo-

[1] Notes on the pneumothorax occurring in phthisis. London, 1869; or Med. Times and Gazette, Jan., Feb. 1869.

On some effects of lung elasticity in health and disease. Med. Chir. Trans., vol. 59, p. 165. 1876.

spheric pressures are equalised. The distended lungs of the healthy chest, with their elasticity in full play, drag upon the mediastinum; which, however, maintains its natural position, because the forces on both sides are equal. But if the elastic traction of one lung be destroyed by relaxation or collapse, the other lung, no longer counterbalanced, itself relaxes as much as possible, and draws the mediastinum away from the middle line.

SECTION VII.

THE HEIGHT OF THE PULMONARY APICES.

The height to which the lungs reach is determined by percussion of the supraclavicular and suprascapular regions.[1]

¶ 1. In Health.—The resonance ceases at a line drawn, from the insertion of the sternomastoid muscle, obliquely upwards to the anterior margin of the trapezius, thence round the muscle, in a line curved with its convexity downwards, to the vertebra prominens. Under

[1] Seitz (autore Heyer): Ueber die percussorische Grenzbestimmung der Lungenspitze. Giessen, 1863. Referred to by Paul Niemeyer; Handbuch der Percussion und Auscultation. Bd. i. 1863.

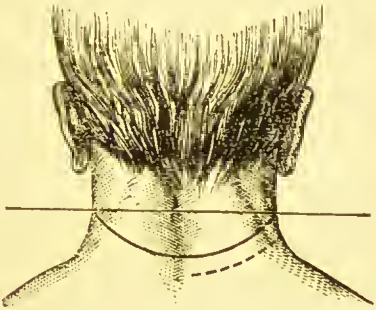
the trapezius, the resonance reaches $1\frac{1}{4}$ to 2 inches above the clavicle: the height is

Fig. 13.

Height of Pulmonary Apices.

mostly equal on both sides, but there may be

Fig. 14.



Height of Pulmonary Apices.

a difference of half an inch in favour of the right side.

¶ II. In Disease.—The apex rises unnaturally high, and bulges, in pulmonary emphysema: it shrinks both vertically and transversely, in phthisis. The practical value of determining the size of the pulmonary apices lies in the diagnosis of commencing phthisis.

SECTION VIII.

VASCULAR MURMURS IN THE LUNGS.

Very probable though the occurrence of murmurs within the vessels of the lungs may be, yet twice only has the fact been proved. In the right supraspinous fossa of a phthisical patient, Gerhardt heard, beside bronchial breathing and ringing rales, a systolic whiff; which was explained, post mortem, by the existence of a dilated branch of the pulmonary artery, running across a cavity, and expanded in one spot to an aneurysm the size of a pease.[1] Between the scapulæ and the vertebræ Immermann once heard systolic murmurs, due to constriction of the pulmonary arteries at their entry into the lungs, and just beyond; constriction caused by

[1] Lehrbuch, 3rd edit. pp. 218, 270.

cirrhotic condensation of the pulmonary tissue.[1] Murmurs of similar character, and presumed to be of similar origin, have been heard by many other persons.[2] There is reason to believe that, in all cases, the branches of the pulmonary artery constitute the seat of the murmur; which, although most frequently heard in phthisis, may be present also in lung simply collapsed, and in pneumonia.

[1] Strictur beider Hauptäste der Lungenarterie und ihrer ersten Verzweigungen in Folge chronischer interstitieller Pneumonie. Deutsch. Arch. für klin. Med., vol. v. 1869.

[2] Cejka: Beobachtungen über das Nonnengeräusch. Vierteljahrschrift: Prag., vol. xxvi. 1850. A murmur, heard between the upper inner angle of the scapula and the vertebræ, attributed to the underlying veins.

Wintrich: Einleitung, p. 171. A murmur, apparently due to the same cause as that described by Immermann, but heard near the heart in front.

Bartels: Ueber systolische Gefässgeräusche in den Lungen. Deutsches Arch. für klin. Med., vol. vi. p. 111. 1869. Narrates several cases believed to exemplify murmurs generated in the branches of the pulmonary artery.

PART THE SECOND.

CHAPTER I.

PULMONARY CATARRH, OR BRONCHITIS.

§ I. Respiratory sounds weakened, and rales: these are the signs of catarrh.

¶ I. Weakening of the respiratory sound is general or local: that is to say, the whole of both lungs, or only a part of them, is so affected. i. Local weak breathing is by far the commoner condition; is due to the presence of mucus in the tubes; may amount to complete suppression of sound; is usually moveable in seat; and of short duration at any spot. ii. General weak breathing is due to swelling of the mucous membrane, or to weakened respiratory movements.

¶ II. Rales are of two kinds, sonorosibilant and mucous. Both kinds hide the respiratory sound more or less. i. Sonorous and sibilant

rales indicate local incomplete obstruction of the larger air-passages by mucus: a cough, by removing the mucus, mostly removes the rale. ii. Mucous rales indicate the presence of a larger amount of mucus in the tubes. The seeming size of the rale is usually proportionate to the size of the tube wherein the rale is produced. A mucous rale requires that the respiration be fairly vigorous: when the ebb and flow of air is much impeded the rale becomes imperfectly developed (obscure rale): a deep breath will sometimes change an obscure into a distinct rale. Often enough there are no rales at all.

§ II. i. Uncomplicated pulmonary catarrh is bilateral, affecting both lungs: the mucous rales, when present, are most abundant behind and at the bases of the lungs, or indeed exist there only. Persistent localisation of the signs of catarrh to one lung, or to parts of the lungs other than the bases, is an almost sufficient proof that the catarrh is complicated with some other disease. ii. Severe pulmonary catarrh is attended, especially in very young children, and in the subjects of rickets, by all the signs of inspiratory dyspnœa, namely, recession of the epigastrium, of the ribs and cartilages below the nipples, and of the supraclavicular spaces. iii.

In the same class of patients, acute emphysema or insufflation of the lungs is sometimes rapidly produced; it is indicated by bulging of the front of the chest. iv. The percussion-note is often impaired, for a few days, over a part, or even over the whole of a lung. The commonest seats of this sign are the apices, the lower lobes, and the middle lobe of the right lung. The cause of the impaired resonance is not known. On the other hand, in both children and adults, patches of unnaturally clear resonance may be met with; probably due to local relaxation of the lung-tissue. v. When catarrh is complicated by disseminated solidifications of the lungs (especially lobular pneumonia and miliary tuberculosis) the rales sometimes acquire a sharp ringing reverberating quality. vi. The deformities, produced by catarrh, are sometimes permanent. They have been already described under the names of pigeon breast, cupping of the lower part of the chest in front, and bulging of the upper part of the chest in front.

§ III. i. Œdema of the lungs, blood and diphtheritic exudations in the air-tubes, and miliary tuberculosis, cannot be distinguished from catarrh by the physical signs alone. ii. Pneumothorax is simulated when there is com-

plete catarrhal obstruction to the main bronchus of a lung; an accident sometimes met with in the stupor of cerebral diseases, for example. The breath-sound is suppressed over the whole of one side, and the percussion-note is clear. But in catarrh the suppression of respiratory sound is very transitory, and the displaced mediastinum and amphoric signs of pneumothorax are wanting. iii. Obstruction of a main bronchus, not catarrhal, is much more abiding than catarrhal obstruction, and is commonly attended by retraction of the affected side.[1] iv. The rale of pleurisy is sometimes mistaken for a catarrhal rale: pleuritic rale however is mostly unilateral. v. A certain combination of the signs of catarrh, discovered in a patient examined for the first time, strongly resembles phthisis.[2] This is not uncommon, epecially in children and young adults. There are dulness to percussion at one apex, weak or puerile breathing there, and universal sonorous or mucous rales. The distinction is to be found in the fact that these signs are very transitory when catarrhal, lasting not more than a day or two.

[1] See chapter ix.

[2] S. Gee: Remarks upon typhoid fever. St. Bartholomew's Hospital Reports, vol. x. p. 13. 1874.

CHAPTER II.

PULMONARY ŒDEMA.

THE simplest kind of pulmonary œdema is that which occurs acutely in the course of renal dropsy: it is to this form of œdema that the following remarks especially apply. The other kinds of œdema of the lungs are usually more or less complicated with other pulmonary lesions, such as the chronic bronchitis and brown induration of cardiac dropsy.

§ I. The physical signs of pulmonary œdema are due to the presence of a large quantity of thin liquid in the air passages.

¶ I. The respiratory sound is hidden by the rales. Bronchial breathing sometimes is heard in compact œdema, apart from any compression of the lung by hydrothorax.

¶ II. Mucous rales, small in size, often sharp and reverberating. True crepitation, either in patches here and there, or much more extensive so as to involve the whole of one or both lungs, is sometimes present.

§ II. i. Pulmonary œdema is always bilateral

sooner or later, but it may attack one lung some hours before the other. ii. Hydrothorax is a complication almost constant; and also bilateral, unless obliteration of one pleural cavity by adhesion render the effusion necessarily unilateral. iii. Great inspiratory dyspnœa sometimes present; attended, it may be, by extreme recession of the infra-mammary regions, even when there is hydrothorax also. iv. Percussion note unaffected: or somewhat diminished in resonance: or unnaturally clear in patches, where the subjacent lung happens to be relaxed in consequence of the œdema or hydrothorax. Dulness to percussion, at the bases of the chest, in proportion to the hydrothorax. v. Dilatation and pulsation of the jugular veins may be sometimes seen.

§ III. The diagnosis of pulmonary œdema from pulmonary catarrh depends more upon the symptoms than upon the physical signs.

CHAPTER III.

PULMONARY CONGESTION.

§ I. The only physical sign of simple pulmonary congestion consists in an accentuation of the cardiac second sound over the pulmonary artery; in other words, the pulmonary second sound is louder than the aortic. Great importance has been attributed to this sign by some physicians. In simple congestion of the lungs the pulmonary sigmoids ought, no doubt, to be shut with greater force than the aortic. But the evidence which auscultation has been supposed to give of increased pulmonary tension is, as Andrew has shown, fallacious.[1] For greater loudness of the pulmonary second sound may be merely relative, and due to weakness of the aortic sound : or the pulmonary sound may be conducted better than the aortic: or, again, a pulmonary sound, which is really accentuated,

[1] On the diagnosis of systolic endocardial murmurs, whose point of greatest intensity is at or near the left apex of the heart. St. Bartholomew's Hospital Reports, vol. i. p. 13. 1865.

may seem not to be so, because conducted badly.

§ II. Passive pulmonary congestion is almost necessarily associated with catarrh and its physical signs. Other complications, also common, are collapse, œdema, hydrothorax, and hæmorrhagic infarctus.

§ III. Brown induration of the lungs is a consequence of chronic congestion. Some impairment of the percussion resonance, especially over the lower lobes and on the left side, is the only sign relative to this lesion.

CHAPTER IV.

PULMONARY HÆMORRHAGE.

§ I. THE physical signs of a moderate bronchial hæmorrhage are simply rales due to the presence of blood in the tubes : when the blood is expectorated as fast as poured out, there will not even be rales.

§ II. Hæmorrhagic consolidation of the lung, when extensive enough (not less than three inches in diameter at the surface) yields the physical signs which would be expected, namely, dulness to percussion and bronchial breathing. Hæmorrhagic infarctus is usually complicated by chronic catarrh and congestion, with their consequences.

CHAPTER V.

PULMONARY EMPHYSEMA.

BY pulmonary emphysema is meant a progressive dilatation of the air sacs and destruction of their septa, associated with increase in the bulk of the lung—hypertrophous emphysema.

§ I. The signs depend upon the enlargement of both lungs. i. Bilateral enlargement of the thorax. ii. Depression of the diaphragm, involving depression of the heart, liver, spleen, and stomach: epigastric pulsation is often present, due, no doubt, to the low position of the heart. iii. Extension of the lung in front of the heart: whereby the area of superficial cardiac dulness is diminished or abolished, and the heart's impulse and sounds become enfeebled. iv. Bulging of the lungs above the clavicles, especially during cough or powerful expiration.

§ II. i. Emphysema is always bilateral, unless there be a lesion of one lung such as to forbid its expansion. When one lung is cirrhosed, or greatly collapsed from unyielding pleural adhe-

sions, it is common to find emphysema of the other lung. ii. The respiratory movements tend to assume the characters described under the name of non-expansive inspiration and expiratory dyspnœa. iii. The percussion-note tends to fall in pitch, that is to say, to become tympanitic; the muffling mostly remains unchanged, or is even increased, although sometimes the note becomes clear in places. iv. The respiratory sound is usually weakened, in consequence of the non-expansive inspiration. And the expiratory sound is often greatly prolonged, in consequence of the expiratory dyspnœa. v. Friction sound is occasionally produced by distended subpleural sacculi. vi. A muscular rumble is sometimes heard over the chest. vii. Emphysema is always associated with pulmonary catarrh, and the physical signs are modified accordingly. Dilatation of the heart is a necessary consequence of long-standing emphysema.

§ III. Pneumothorax is the only disease which can be confounded with emphysema. But bilateral pneumothorax is incompatible with life, and emphysema is bilateral. Moreover, amphoric signs are never present in emphysema.

CHAPTER VI.

PULMONARY ATROPHY.

ATROPHY of the lungs, with dilated air-sacs, occurs as a part of general senile atrophy, or as a consequence of previous pulmonary disease, especially arrested phthisis.

§ I. There are no physical signs essentially belonging to the lesion.

§ II. Its accidental characters are these: i. Shape of chest uncertain, except that it is not bilaterally enlarged. ii. But it has all the fixed and inexpansible look of emphysema; the sterno-mastoid muscles stand out strongly against the sunken supra-clavicular spaces, unless they be bulged by a forcible expiration. iii. Diaphragm depressed; epigastric pulsation. iv. Heart covered by lung. v. Tympanitic percussion note over front of chest. vi. Signs of catarrh are common.

§ III. To these characters add the negative condition, that there are no definite signs of

other disease ; and we have all the grounds for physical diagnosis of pulmonary atrophy in any case of which the symptoms point to disease of the lungs.

CHAPTER VII.

ASTHMA.

BY asthma is meant dyspnœa, paroxysmal and idiopathic, which is to say, not symptomatic of any known structural disease of the lungs.[1]

§ I. The physical signs proper to asthma; or, in other words, the signs of an asthmatic paroxysm. i. Expiratory dyspnœa; expiration forced; lower parts of chest fixed and altogether immoveable; no abdominal movements of respiration, or hardly any. ii. Diaphragm depressed. iii. Breath sounds weakened, sometimes almost inaudible. iv. Sonorous and sibilant rales common: mucous rales also towards the end of the attack. v. Heart sounds very weak and muffled.

§ II. Asthma is usually accompanied by signs of pulmonary emphysema, atrophy, or catarrh.

[1] "A true nervous or spasmodic asthma, without any other fault in the lungs than an uncommon delicacy or irritability of their nerves, is a disease which we seldom meet with." The Works of Robert Whytt, M.D., p. 602. Edinburgh, 1768.

CHAPTER VIII.

PULMONARY COLLAPSE.

§ I. Collapse of a few vesicles is indicated when deep inspiration brings out a crepitant rale, audible for a few breaths only, and then heard no more.

§ II. Collapse of larger portions of lung requires, for diagnosis, two conditions, namely, that the lesion be extensive, and that the collapsed lung be in contact with the chest wall.

¶ I. Extensive collapse of this kind sometimes occurs acutely. A lesion most common in infants, and especially in feeble infants, as a consequence of bronchial obstruction, catarrhal or other. The signs are simply those of consolidated and contracted lung, and do not suffice for the diagnosis unless we weigh them in relation with the whole history of the disease. i. Recession of the base of the chest (when the chest is pliant), in proportion to the extent of collapse. ii. Dulness to percussion. iii. Bronchial breathing. iv. Rales are usually present; and will be quite gurgling in character, if the

collapse surround large tubes, such as those at the root of the lung.

¶ II. Extensive collapse may be chronic. i. In this case, grey induration of the affected part slowly supervenes.[1] The signs are those of shrunken and consolidated lung: local retraction of the chest wall, impaired resonance to percussion, bronchial breathing, and haply signs of catarrh or dilated bronchi. The diagnosis from phthisis depends greatly upon the whole history of the case. ii. Absorption of pleural effusion sometimes leaves the lung adherent to the chest wall and permanently collapsed,—a state which will be discussed in the chapter upon Adherent Pleura.

[1] Thomas Addison: A collection of his published writings, p. 28. New Sydenham Society. 1868.

CHAPTER IX.

PLUGGING OF TRACHÆA OR BRONCHUS.

THE trachæa or a large bronchial tube may be plugged by a foreign body which has entered through the glottis or through a fistulous opening.

§ I. The signs immediately due to the obstruction are these :—i. Inspiratory dyspnœa, attended by imperfect movements of the chest walls, on one or both sides, according to the seat of the obstruction. ii. Percussion note not much affected. iii. Respiratory sounds weakened, it may be almost abolished, over the parts involved. iv. Sonorous rale, inspiratory and expiratory, produced at the seat of obstruction, the plugging being incomplete. The rale is usually loud, and heard over a great extent of chest : the seat of the obstruction is not necessarily nearest to the spot where the rale is heard loudest. v. A palpable thrill, due to the same vibration as the rale ; inspiratory or expiratory ; felt over one side or both.

§ II. Sooner or later, plugging of a bronchus is followed by collapse, dilated tubes, and destructive pneumonia. The physical signs are these :—i. Permanent recession of the chest wall is common; when it is unilateral, the other side is sometimes distended. Yet the shape of the chest is not always altered; it is in a few cases quite natural. ii. Percussion note over the affected part much impaired. iii. The auscultation signs depend greatly upon the degree of bronchial obstruction; sometimes there is little or no breathing sound; sometimes there are bronchial or cavernous breathing, and rales more or less reverberating. For further remarks, the reader may refer to the chapter on Destructive Pneumonia.

CHAPTER X.

PLEURISY.

ALTHOUGH pleurisy cannot exist without inflammatory effusion, yet the phrase, pleurisy with effusion, has come to be applied to those cases only in which the effusion is considerable; these will be discussed hereafter. In the present place I purpose to treat of pleurisy attended by small effusion.

§ I. Pleurisy of this kind is often very local. It is indicated by local friction sounds. The resonance of the affected part of the chest may or may not be impaired, according to the amount of the exudation.

§ II. Pleurisy of this kind is sometimes universal, involving the whole of one pleura. i. The affected side is retracted, it may be considerably, and moves much less freely than in health. ii. The percussion-note is raised in pitch and muffled, over the greater part or the whole of the side. The sense of resistence is increased. When the disease affects the left

side, the superficial area of cardiac dulness is extended. iii. The respiration generally is weak, and attended by a friction sound (especially in the complemental space), or by a wide-spread rale, indistinguishable from the mucous rale of catarrh or phthisis.[1] At places the breath-sound may be bronchial, in all degrees of intensity, up to a hollow resonance, such as Laennec himself would have supposed to leave no doubt of cavity.[2] iv. Add to the physical signs hectic fever, and we cease to wonder that pleurisy of this kind is usually mistaken for phthisis more or less advanced. However, the pleuritic patients recover completely, without a vestige of disease left behind, save haply a slight unilateral retraction of the chest, or a cuplike depression. Whenever the signs of a case of supposed phthisis are in some respects peculiar; whenever they indicate advanced disease limited to one side of the chest; whenever cavernous signs are heard in unusual places; it is well to weigh the possibility of simple pleurisy. The

[1] Thomas Addison: Works, p. 88.
Trousseau: De la pleurésie: Clinique médicale, vol. i. p. 610: 2nd edit. 1865.

[2] I have heard this pleuritic cavernous breathing most often near and below the right nipple.

most useful guide to a physical diagnosis is this, that the signs of pleurisy are more marked in the lowermost part of the chest, and that the signs of phthisis are, as a rule, more marked at the upper part. Careful microscopic examination of the sputa will sometimes help us when physical examination fails.

CHAPTER XI.

PLEURAL EFFUSION.

THE different kinds of effusion into the pleura may be thus classified :—

1st. Gaseous	. . .	Pneumothorax.
2nd. Liquid : i. dropsical	.	Hydrothorax.
ii. inflammatory		Pleurisy with effusion.
iii. blood	. .	Hæmothorax.
3rd. Food and drink.		

The effusion is either unilateral or bilateral : either total (filling the whole of the pleural cavity) or partial : and a partial effusion is either loculated (enclosed in adhesions) or free. The lung collapses in a degree proportionate to the abundance of the effusion. Wherefore total pleural effusion is always unilateral, inasmuch as collapse of both lungs is obviously incompatible with life.

With reference to the third kind of pleural effusion, no more need be said than that it is very uncommon, that it was due, in Boerhaave's

case,[1] to a rupture of the œsophagus near to the stomach, and that the signs would probably be those of hydropneumothorax.

[1] Atrocis, nec descripti prius, morbi historia. Secundum medicae artis leges conscripta ab Hermanno Boerhaave. Lugd. Batav. 1724. The œsophagus broke during violent retching; the food and drink escaped into both pleuræ.

CHAPTER XII.

PNEUMOTHORAX.

THE varieties of pneumothorax are these :—

1st. Air and liquid present in the cavity :	
i. Cavity large :	
α. closed	Hydro-pneumothorax.
β. with an external fistula .	Fistulous Empycma.
ii. Cavity small	Loculated Pneumothorax.
2nd. Air alone present in the cavity .	Pure Pneumothorax.

Art. I.—Closed Hydropneumothorax.

§ I. Its physical signs are these :—Unilateral distension of the chest, tympanitic percussion sound, enfeebled respiration, and amphoric phænomena.

¶ I. Distension of the chest is indicated by :—i. Unilateral enlargement ; sometimes so great as to cause an excess of three inches in the semicircumference on the affected side. ii. Depression of the diaphragm ; sometimes so great as to

force the upper surface of the liver altogether below the level of the costal margin in front, and to produce a band of tympanic resonance in the abdomen, above the liver dulness. iii. Displacement of the mediastinum towards the unaffected side occurs almost instantaneously in perforative pneumothorax; at first due no doubt to traction exerted by the lung which is not collapsed; but before long the air in the pneumothorax comes to exert positive pressure upon the mediastinum.

¶ II. The percussion-sound falls in pitch and increases in duration, that is to say, becomes tympanitic, in proportion to the distension of the pleura. The note, however remains muffled; and, in fact, when the distension is extreme, the muffling approaches dulness. Amphoric quality is sometimes possessed by the percussion note, sometimes not. Where liquid is present, non-resonance will be found: the liquid effusion is free, moveable, and changes its position with change in the position of the body.

¶ III. The respiratory sound is weakened in proportion to the collapse of the lung. Sometimes the collapse is so complete, that no breathing is audible, except in the vertebral grooves. When the lung has been much solidified by pre-

vious disease, so that collapse can hardly ensue, a respiratory sound, more or less loud and bronchial or amphoric, will be heard all over the pneumothorax.

¶ IV. Amphoric signs, indicative of a large cavity, are present. i. Amphoric hum may attend the sounds of breathing, coughing, or talking. And let it not be supposed that amphoric respiration is necessarily due to air passing freely out of the lung into the pleural cavity and back again: on the contrary, this is seldom the case; the breath sounds heard are pulmonary sounds, and acquire their amphoric quality by transmission through the pneumothorax. ii. Metallic tinkling may be present. iii. The bell-sound is a very important sign of a large pneumothorax. iv. Succussion splash occurs when the quantity of liquid is considerable.

§ II. The inspiratory movement of the affected side is non-expansive: the vocal thrill is diminished, or, even abolished. The respiration on the unaffected side is puerile. When the pneumothorax is secondary to phthisis, the apex of the lung often remains adherent. In an old pneumothorax a large ulcerous opening is sometimes formed between the cavity and a large air-tube: thereupon, all active distension of the

side ceases. In rare cases air is effused into the pericardium as well as into the pleura, whereby the signs indicative of a displaced mediastinum are lost.

Art. II.—Fistulous Empyema :

Differs from a closed hydropneumothorax in that the affected side is distended very slightly, or not at all, or more frequently is contracted. Consequently the signs due to a large air-containing cavity are seldom present. The sound of lung-shock is occasionally produced in a fistulous empyema.

Art. III.—Loculated Pneumothorax :

Is not common; when associated, as it often is, with a permanent pulmonary fistula, the diagnosis from a cavity formed within the lung becomes difficult, or impossible.

Art. IV.—Pure Pneumothorax :

Is an uncommon lesion, mostly of traumatic origin, but occasionally due to rupture of distended pulmonary air-vesicles. The physical signs are the same as those of a closed hydropneumothorax, excepting such as are due to the presence of liquid.

Traumatic rupture of the diaphragm, on the left side, is apt to be followed by a state of things which has been mistaken, during life, for pneumothorax.[1] The stomach and colon pass up into the pleural sac; they become greatly distended with gas; the lung collapses. Hence displacement of the mediastinum, such that the heart beats to the right of the sternum: tympanitic percussion note over nearly the whole of the left side: and great weakening or abolition of the breathing sounds there. The bell sound would probably, the metallic tinkle and succusion splash might possibly, be present. Enough, in this place, to have pointed out the necessity of a cautious diagnosis.

[1] Butlin: Notes of three cases of air in the cavity of the pleura, as the result of injury. St. Bartholomew's Hospital Reports, vol. xi. p. 255. 1875.

CHAPTER XIII.

HYDROTHORAX.

HYDROTHORAX and œdema of the lungs, pleural and pulmonary dropsy, often co-exist. A serous effusion due to pleurisy sometimes obtains the name of hydrothorax; but the word is used in this place to signify a simple dropsy. Hydrothorax tends to be bilateral, although on account of local conditions, the quantity of effusion is not always equal on both sides. And, being bilateral, the fluid cannot occupy more than a portion of the pleural cavities; the effusion is partial.

i. When pulmonary œdema also is present, it is possible for great inspiratory dyspnœa, such as to simulate laryngeal obstruction, to concur with copious hydrothorax. ii. The diaphragm is depressed: the base of the thorax expanded: the position of the mediastinum remains unchanged. iii. Dulness to percussion co-extensive with the effusion. The liquid effused, not being enclosed in adhesions, is freely moveable in the pleura,

and occupies the most depending part: upper limit of dulness, for the same reason, horizontal. iv. Respiratory sound and vocal resonance either simply weak or feebly bronchial, over the regions where the percussion note is dull: sometimes a little mucous rale. In cases of general anasarca in the adult, it is not possible to detect an effusion much less in quantity than half a pint in each pleura.

CHAPTER XIV.

PLEURISY WITH EFFUSION.

PLEURISY with effusion is usually unilateral. The course of pleurisy may be divided into periods of increase, height, and decline.

§ I. Period of increase.

¶ I. Sometimes a friction sound is the earliest sign of pleurisy with effusion. Or, instead of a friction sound, a pleuritic rale (page 213), may be heard over the whole of one side of the back. The primitive friction is usually much more local : its common situation being over the base of the lung, in front or at the side ; that is to say, over the complemental space of the pleura.

¶ II. More frequently, however, the earliest signs are those of a liquid effusion : the same signs, when they have been preceded by a friction sound, or a pleuritic rale, rapidly supersede them. The liquid tends to collect, as soon as formed, in the lowest place. At first, when the quantity is small, the lung is simply relaxed, and swims upon the effusion : but as the liquid

accumulates it compresses the lung, and renders it more or less empty of air. i. The great sign of liquid effusion is a co-extensive dulness to percussion. This dulness is not at first wholly due to the effusion, but is partly dependent upon the associated collapse; that is to say, a layer of liquid an inch or more thick would transmit percussion resonance of the lung, were the lung resonant. The dulness begins at the lowest part of the chest behind; the note being natural elsewhere. In the adult, less than half a pint of liquid cannot be detected by percussion.[1] When the effusion rises higher than the angle of the scapula, the lung will have relaxed to such an extent as to give a clear subtympanitic or trachæal note above the nipple of the same side in front: a sign not always present even in cases watched day by day from the onset. Whether, by further increase in the quantity of the fluid, the whole back become dull before the front is so at all, or whether the upper level of the fluid be comparatively horizontal, depends upon this circumstance, namely, whether the patient took to his bed early in the disease, or whether

[1] Wintrich: Die Krankheiten der Pleura. Virchow's Handbuch der spec. Path. und Ther., vol. v. part i. p. 249. 1857.

he kept about while the effusion was going on. So that, when the effusion is small, the dulness may be wholly posterior, that is to say, the lateral region may be entirely resonant. Even when absolute dulness is confined to the base, there is usually some impairment of resonance all over the back on that side. The level of dulness is always higher behind than before. The line of demarcation between resonance and non-resonance is sharper before than behind. The anterior clear resonance, when present, is sometimes of cracked-pot quality. ii. In proportion to the amount of effusion, the side is enlarged, the diaphragm depressed, and the mediastinum displaced. iii. The vocal thrill is diminished where dulness to percussion exists, and is wholly abolished in great distension of the side. iv. The respiration is at first weakly vesicular, and sometimes remains so throughout the disease. But mostly the breathing soon becomes bronchial. With progressive increase of effusion, the bronchial breathing tends to become less and less loud until, at last, it is wholly suppressed. But sometimes, although the quantity of fluid be very great, loud bronchial breathing is heard all over the affected side : the fact being that the loudness depends, not in-

versely upon the quantity of fluid effused, but directly upon the amount of lung left permeable to air : the quality of the liquid, in respect of homogeneousness, is probably not without influence on this behalf. Breathing intensely bronchial, large mucous rales, and pectoriloquy, might lead the unwary into the diagnosis of phthisis : that the respiratory sound should ever be attended, in simple pleurisy with effusion, by an amphoric hum, is, I must confess, hard to believe.[1] v. Vocal resonance weak and bronchial in much the same manner as the respiratory sound.[2] When the effusion is partial, with clear resonance in front, the bronchophony is sometimes ægophonic about the angle of the scapula.

§ II. The effusion at length reaches its height. This sometimes will not be until the pleural cavity is tensely full ; or the effusion may stop at any point short of that extreme. When the quantity of fluid on the left side is very great, the left half of the diaphragm is occasionally de-

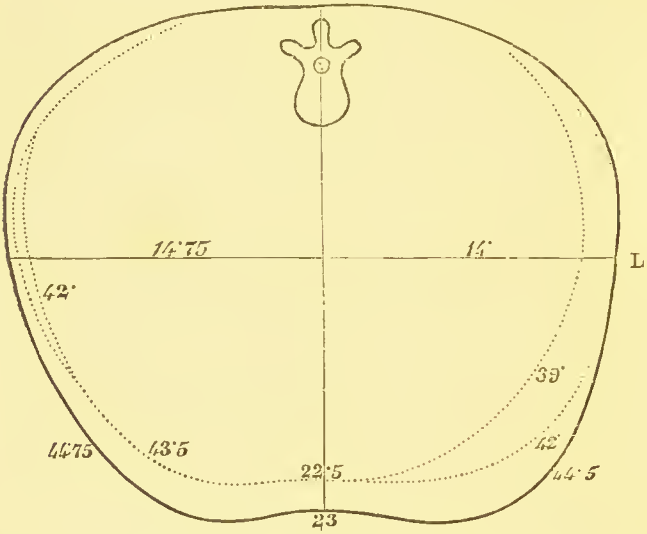
[1] Thomas Addison : Works, p. 73.

Landouzy : Nouvelles données sur le diagnostic de la pleurésie et les indications de la thoracentèse. Archives générales de médecine : series v. vol. viii. p. 513. 1856. He gives the references to Rilliet and Barthez, Béhier, and other French writers on this topic.

[2] For Baccelli's opinions with refence to the influence of the quality of the effusion upon pectoriloquy, see p. 122.

pressed to such an extent that not only can the lower margin of the spleen be felt, but even its

Fig. 15.



COURSE OF PLEURISY WITH EFFUSION, LEFT SIDE.

Outer line — horizontal section before paracentesis.
Middle line (dotted) — four days after paracentesis.
Inner line (dotted) — three weeks after paracentesis.

upper margin, in fact its whole circumference. And at the same time, the thrusting of the heart and mediastinum over into the right side of the thorax may cause the right wing also of the diaphragm to be depressed to an almost equal degree ; a point ascertained by examination of the liver. When the effusion is partial

it does not easily shift with the position of the body, as a dropsy of the pleura does. The semi-circumference is sometimes actually less on the diseased than on the healthy side.

§ III. Period of decline. When a pleural effusion undergoes absorption, or is discharged by paracentesis, the following series of physical signs are noted.

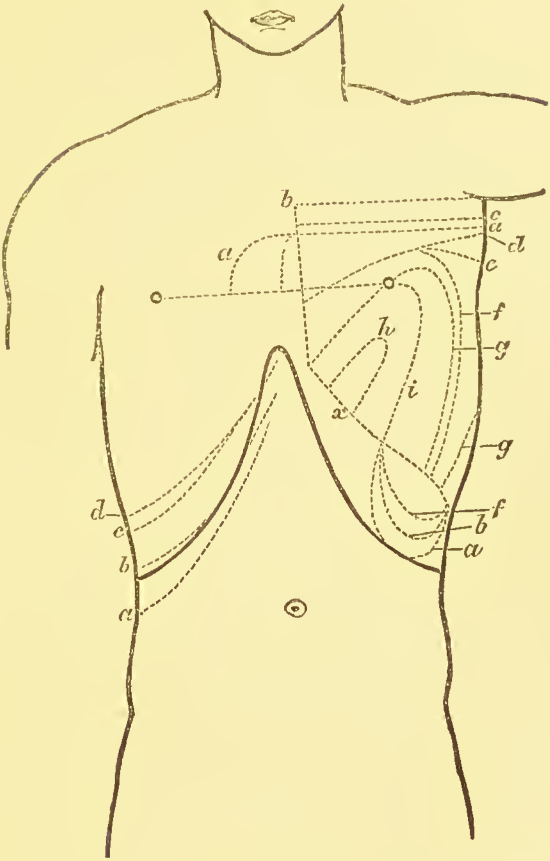
The diaphragm and mediastinum go back towards their natural position: to follow the retreating organs is the best means of marking the progress of absorption, whilst the quantity of the effusion remains great. The distension of the affected side becomes less; and accurately to register this fact is a most important service rendered by the cyrtometer. When the effusion has so far diminished that the lung again comes into contact with the chest-wall, percussion enables us to follow the falling level of fluid. And, at the same time, auscultation will sometimes inform us when and where actual adhesion of the opposed surfaces of the pleura has occurred.

With reference to the percussion signs more particularly. Dulness, only just short of absolute, and due to the unexpanded lung, often remains for a considerable time after perfect

adhesion has occurred. This fact, and another before alluded to, namely, that the limit of absolute dulness cannot be always sharply defined posteriorly, sometimes render the attainment of our aim in percussion difficult. Nevertheless a distinction between dulness which is absolute and that which is not, can usually be made by careful superficial percussion: and the difficulties, which I have spoken of, are by no means present in every case. The manner in which the effusion is absorbed (like the manner in which it is effused) depends upon circumstances, whether the patient is able to keep upright during his illness, or not. In the former case, the course of a decreasing effusion has been carefully studied by Damoiseau.[1] The upper surface of the liquid, when it reaches as high as two inches above the nipple, is horizontal: when lower than this point, the dulness forms irregular parabolic curves, which become smaller and smaller, and last of all disappear at the lowest parts of the thorax. The fluid is mostly absorbed in the following order: from the vertebral groove near the root of the lung;

[1] Recherches cliniques sur plusieurs points du diagnostic des épanchements pleurétiques. Arch. gén de Méd., series iv. vol. iii. p. 129. Oct. 1843.

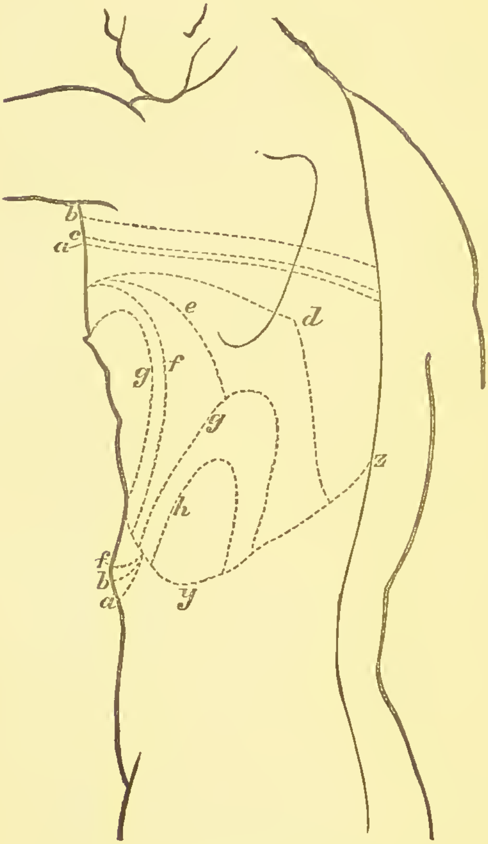
Fig. 16.



THE COURSE OF AN EFFUSION INTO THE LEFT PLEURA: FROM DAMOISEAU.

a a = limits of effusion, heart, liver, and spleen, when patient first seen.
b b = same on first day of treatment. *c c* = second day.
d d = third day *e e* = fourth day.
f f = fifth day. *g g* = morning of sixth day.
i = evening of sixth day.
hh = last limits of effusion previous to disappearance, *i.* tenth day.
x y z = lower limit of pleura.

Fig. 17.



COURSE OF AN EFFUSION INTO THE LEFT PLEURA: FROM DAMOISEAU.

from the supramammary region; from the rest of the vertebral groove and infrascapular region; from the inframammary region, and lastly from the lower lateral region; concerning which point it is important to remember that the lowest part of the pleural cavity, in the upright position, is in the axillary line. The curve of the sinking fluid is sometimes double, as happened to be the case with the patient represented in the drawing.

Disappearance of absolute dulness at any spot is sometimes attended, for a day or two, by friction sound, indicative of restored contact between the pleural surfaces: redux friction, as it is usually called.

The latest physical sign, dependent upon absorption, is the retraction of the affected side. Cup-like sinking of the lower part of the sternum occasionally ensues. In some cases these deformities tend to disappear gradually, in others they are permanent.

§ IV. The Diagnosis. i. Cancer of the lung closely resembles pleural effusion in respect of the physical signs. But cancer does not cause enlargement of the affected side: nor does the dulness of cancer usually follow the laws which have been laid down with regard to pleural

effusion.[1] ii. Hydatid tumours within the chest are not common: they hardly admit of diagnosis until the peculiar membrane is expectorated, or removed during the operation of paracentesis. iii. Chronic collapse and induration of one lung, in whole or in part, has been mistaken for pleural effusion. The case of collapse of a whole lung will be discussed in the chapter on Adherent Pleura. The collapse of the lower lobe of the left lung, which depends upon dilatation of the heart or pericardial effusion, is not always easily distinguished from a moderate pleural effusion. The most useful diagnostic sign is that upon which Damoiseau justly laid much stress, namely, the greater dulness and sense of resistence yielded by gentle percussion over a pleural effusion than over a simply collapsed lung. iv. Acute pneumonia can hardly be confounded with pleural effusion unless the tubes of pneumonic lung be plugged with mucus, so as to obstruct conduction of the breathing sounds. Much weight must be allowed to the fact that pleurisy with effusion tends to enlarge the chest, alter its shape, and displace the diaphragm and mediastinum; and that pneumonia does not. v. But with chronic pneumonia and phthisis of

[1] See chapter xxii.

the lower lobe it is very different: the diagnosis of these lesions from a chronic loculated pleural effusion is often impossible at first. The means of distinction is to be found in the destructive nature of chronic pneumonia and phthisis; lesions which tend to disintegration of the lung, whilst in pleurisy there is no such tendency. So that we must watch for signs of disintegration, such as bronchial breathing gradually increasing in intensity, and rales, becoming more and more loose and reverberating. Microscopic examination of the sputa, and puncture of the chest with a small cannula will help. vi. Hepatic tumours, especially hydatids and abscesses, sometimes reach so high in the chest as closely to simulate pleural effusion on the right side. The diagnosis is not always possible. The clue to it lies in the detection of hepatic enlargement by abdominal examination. vii. To distinguish an abscess situated between the liver and the diaphragm is impossible, unless the abscess point below the costal margin. Indeed cases of this kind are often complicated with loculated empyema at the base of the right chest.

CHAPTER XV.

EMPYEMA.

§ I. An empyema of the whole of one pleural cavity affords physical signs identical with those which have been described under the head of pleurisy with effusion. Often enough the distension of the affected side is anything but great: the heart for instance may be scarcely at all displaced, a fact which is sometimes due to pleural adhesion over the pericardium. The signs of pneumo-empyema (pyopneumothorax) and of fistulous empyema have been already described.

§ II. Small collections of pus in the pleura are sometimes enclosed in dense adhesions: loculated empyemata.

¶ I. These partial empyemata occur in the following situations: i. Most commonly in the back of the pleural cavity, and between the lung and the diaphragm: the latter, or diaphragmatic empyemata, are usually larger behind than in front. ii. Less commonly in

the lateral region, in the anterior region, and between the lung and pericardium. iii. Sometimes there are many loculi in one pleural cavity : sometimes there is a loculated empyema on each side.

¶ II. These empyemata are often complicated : when diaphragmatic, with subdiaphragmatic and hepatic abscess : when on the left side, with purulent pericarditis.

¶ III. The physical signs are these. i. Chest contracted on the affected side ; or contracted above and distended below ; or there may be a local bulging. ii. Breathing movements of the pleuritic side diminished. iii. Heart sometimes displaced, often not. Liver sometimes displaced downwards in diaphragmatic empyema : however, even in a large diaphragmatic empyema on the right side, the liver may be not depressed. Stomach note, when the left side is affected, often reaches high, say to the nipple level. iv. Percussion note sometimes impaired over whole of affected side, sometimes not. When the empyema is superficial, dulness at the spot. v. Respiration usually simply weak all over the affected side : sometimes bronchial where the empyema is superficial. Crackling rales are common.

¶ IV. The diagnosis is often difficult; it usually relates to destructive pneumonia, phthisis, or enlargement of the liver. When complicated with catarrh, the resemblance to tuberculosis, local or general, is great.

§ III. Excessively abundant empyematous effusions, on the left side, sometimes pulsate rhythmically with the heart: pulsating empyemata. The most frequent seat of the pulsation is the anterior part of the chest around and above the nipple. The heart is displaced very much to the right.[1]

[1] The first record of a pulsating empyema is found in Baillou: Epidemiorum et ephemeridum liber secundus: constitutio hiemalis anni dom. 1576. Opp. edit. 1734, Venetiis, vol. i. p. 128. Filia venerabilis Colettæ, etc. A pulsating swelling, about the left breast, which was thought to be an aneurysm, until it burst and discharged pus.

CHAPTER XVI.

ADHERENT PLEURA.

§ I. Very densely adherent pleuræ are attended by all the signs of unilaterally contracted chest. The percussion sound will be deficient, and the breath sound enfeebled, over a large surface of the affected side.[1] Sometimes the signs spoken of in the chapter on pleurisy[2] are present; namely, those which simulate consolidation of lung.

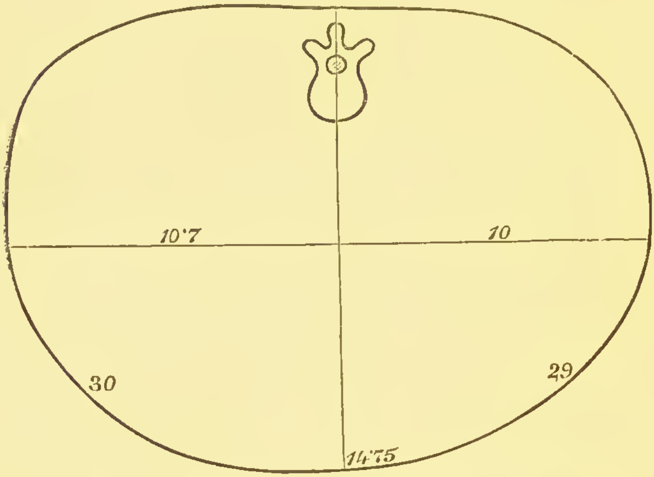
§ II. But much looser adhesions, such as are

[1] Barker has narrated a most unusual form of disease which was probably dependent upon past pleurisy. The right lung was wholly collapsed, and adherent to the chest walls; the mediastinum was displaced so much to the right that the heart lay embedded, as it were, in the right lung; the diaphragm and liver were raised; the left lung was emphysematous. The physical signs were: fixity of the right side of the chest; heart's impulse impalpable; absolute dulness to percussion over right side; no cardiac dulness; respiratory sounds inaudible on right side. Cases illustrating some difficulties in the diagnosis of pleuritic effusion. Medico-Chir. Trans., vol. xxxiv. p. 131. 1851.

[2] Part ii. ch. x. § ii.

so often unexpectedly found post mortem, and which influence the percussion and auscultation

Fig. 18.



UNILATERAL RETRACTION OF LEFT SIDE OF CHEST CONSEQUENT UPON AN ADHERENT PLEURA.

of the chest in no respect, may be sometimes (perhaps always) discovered by the cyrtometer, when one pleura only is obliterated. A proof of this is afforded by the tracing annexed, which was taken from a child who died after an operation, and in whom no symptoms had existed to raise a suspicion of the universally adherent pleura on te hleft side.

CHAPTER XVII.

PNEUMONIA.

FOR present purposes it is convenient to divide aeute pneumonia into two kinds, lobar and lobular, the eonsolidation being, in the former case massive, and in the latter disseminated.

Art. I.—Lobar Pneumonia.

The physieal signs differ aeeording to the different stages of pneumonia deseribed by the morbid anatomist.

Stage I. Aetive sanguineous fluxion upon the lung is eharacterised by weak respiratory sound, and erepitant rale. The pereussion sound is not materially ehanged : sometimes the note beeomes traehæal and clearer, a fact whieh is probably due to partial relaxation of the lung-tissue. Whether it be that erepitation is not always present, or that the duration of this stage is so short that the majority of patients have entered upon the next stage before they are seen by the physician, is a matter not yet

decided: this is certain, that crepitation is a sign somewhat uncommon.

Stage II. Hepatisation of the lung is characterised by dulness to percussion, bronchial breathing, and bronchophony. i. In persons whose chest-walls are resilient, the dulness will be found less absolute than is afforded by pleural liquid effusion, cancer of the lung, or dense phthisical consolidation. When, as is sometimes the case, islets of unsolidified lung are imbedded in the surface of the hepatised tissue, they afford the clear resonance of relaxed lung, or even a cracked-pot sound. A cavity, or a large bronchus, separated from the surface by a thin layer of pneumonic lung, will produce the same effects. ii. The bronchial breathing of pneumonia differs from that commonly met with in other diseases by being more whiffing, tubular in short. However, even in genuine lobar pneumonia, the bronchial breathing is not seldom of the ordinary softer kind. The bronchophony is commonly of the sniffing variety. All breathing sound and vocal resonance may be absent over hepatised lung: this condition is either transient or permanent; when transient it is due to obstruction of the tubes by mucus, which a cough can remove; when permanent,

the air-passages contain solid exudation or coagula. In infants the bronchophonic cry is often the only auscultation-sign of pneumonia which can be obtained. iii. Sharp reverberating mucous rales are sometimes present. Occasionally friction sounds also: indeed, friction may be the earliest sign of deeply-seated pneumonia. iv. Wintrich[1] and Ziemssen[2] have shown, the former with reference to adults and the latter to children, that, in lobar pneumonia of the lower half of a lung, the chest, on that side, is expanded to the state of deep inspiration. I have already pointed out how much this expansion is less than that of a pleural effusion; moreover, pneumonia never displaces the heart or the diaphragm. The state of deep expiration is the best for discovering the permanent inspiratory expansion of pneumonia. v. Pneumonia of the upper part of the lung behind is sometimes attended by the clearest trachæal percussion note in front on the same side.

Stage III. The hepatisation mostly undergoes resolution; which is characterised by progressive diminution of the bronchial quality of

[1] Einleitung, p. 84.

[2] Pleuritis und Pneumonie im Kindesalter. Berlin, 1862, p. 235.

the breathing, by the occurrence of mucous rales and by gradual restitution of the pulmonary percussion-note. Abundant true crepitation may be heard during this stage: crepitation having all the characters before described, and not the so-called redux crepitation, which is only a mucous rale. The percussion-note may become trachæal and clear for a day or two. A considerable degree of impaired resonance often remains for a long time after all the acuteness of the pneumonia has passed away. Occasionally the solidified tissue softens rapidly down into an abscess, a condition which does not admit of diagnosis.

The diagnosis of lobar pneumonia is seldom difficult, the physical signs and symptoms being taken together. When the breathing sounds are not heard over hepatised lung, a pleural effusion is somewhat simulated.

Art. II. Lobular Pneumonia.

Severe catarrhal or diphtheritic bronchitis occurring in children, old people, or debilitated persons, is very apt to be accompanied by lobular pneumonia. If the pneumonic foci be discrete, the signs are not more than those due to the catarrh. If the foci be confluent over a

considerable extent of lung, dulness to percussion, bronchial breathing, and sharp reverberating rales may be heard : over the middle lobe of the right lung for instance. The pneumonia of measles, which is commonly deemed to be of the lobular kind, certainly sometimes yields all the signs of the lobar disease.

CHAPTER XVIII.

DESTRUCTIVE AND GANGRENOUS PNEUMONIA.

DESTRUCTIVE pneumonia due to plugging of a bronchus has been already described. There are moreover other, yet similar, causes of the lesion, namely: i. ulceration of a bronchus, and discharge thereinto of disintegrating material, mostly derived from caseous bronchial glands: ii. compression of a bronchus by a tumour of some kind, usually aneurysmal or cancerous. The primitive pneumonic consolidation tends to proceed to slow ulceration and formation of cavities, or to gangrene. Dilatation of the tubes is common.

§ I. Pneumonia due to compression of the bronchi.[1] Dulness to percussion over the whole

[1] G. Budd: On some of the effects of primary cancerous tumours within the chest. Medico-Chir. Trans., vol. 42, p. 215. 1859.

Gull: On destructive changes in the lung from diseases in the mediastinum invading or compressing the pneumogastric nerves and pulmonary plexus. Guy's Hospital Reports, series iii. vol. 5, p. 307. 1859.

of the affected lung, or over the lower part of it; absence of vocal thrill, of vocal resonance, and of breathing sounds, over the same region: these are the physical signs. The diagnosis is from pleural effusion, or from tumour of the lung. With regard to pleural effusion, the shape of the chest must be studied with the help of the cyrtometer, inasmuch as pneumonia does not dilate the chest; nor is the mediastinum displaced: as a last resource, puncture of the chest may be practised. With regard to cancer or hydatids of the lung, the physical diagnosis is well-nigh impossible.

§ II. Pneumonia due to bronchial ulceration.[1] Dulness to percussion over the lower part of the lung: bronchial breathing, weak at first, becoming more and more cavernous: mucous rale, becoming more and more reverberating and gurgling towards the end of life: these are the physical signs. No unilateral distension of the chest, and no displacement of the mediastinum. The diagnosis from loculated empyema is often impossible, except by puncturing the chest.

The diagnosis of pulmonary gangrene, what-

[1] S. Gee: On the chronic pneumonia which is associated with disease of the bronchial and trachæal lymphatic glands. St. Bartholomew's Hospital Reports, vol. xiii. 1877.

ever be its origin, depends upon the physical signs of a breaking-down lung; taken together with the characters of the sputa, namely, the fœtor, and the abundance of pulmonary elastic tissue to be seen by microscopic examination.

CHAPTER XIX.

EMBOLIC PNEUMONIA, OR PYÆMIC INFARCTUS.

¶ I. The physical signs are chiefly due to the attendent pleurisy: namely, friction sound over any part of the chest; or the signs of pleural effusion at the base, dulness to percussion and bronchial breathing.

¶ II. The consolidation itself may be large enough to afford signs. A superficial infarctus, the size of a walnut, will yield, in a lean adult or a child, distinct dulness to percussion and bronchial breathing.

¶ III. Pneumothorax may ensue.

CHAPTER XX.

PULMONARY TUBERCULOSIS.

ACUTE or chronic pulmonary tuberculosis, if disseminated, that is to say, not going on to massive consolidation or phthisis, seldom affords physical signs which have any direct relation to the tubercle.

¶ I. The lesion is sometimes wholly latent; a most copious formation of miliary tubercle being found after death in lungs which during life yielded no physical signs of disease whatever.

¶ II. The commonest form of the lesion is the bronchitic, and the signs are these: Percussion-note either unaltered, or somewhat raised in pitch, the resistence being increased at the same time. Breath sounds weak; sometimes faintly bronchial here and there. Mucous rales, which are sometimes sharp and reverberating, sometimes not.

¶ III. An acute pulmonary tuberculosis

sometimes takes on a pneumonic form; that is to say, a massive tuberculous consolidation occurs so rapidly as to afford crepitant rale, and most of the signs of lobar pneumonia.

CHAPTER XXI.

PULMONARY PHTHISIS.

BY pulmonary phthisis is meant massive tubercular [1] consolidation which tends to go on to ulceration.

§ I. The physical signs of phthisis depend upon these particulars: the consolidation itself; diminished bulk of the solidified part; the localisation of rales in the solidified part; and the formation of cavities.

¶ I. i. Consolidation is indicated by diminution of percussion resonance; the pitch of the note rises and its clearness diminishes until, in some cases, absolute dulness is reached. ii. In the earlier stage of progressive solidification the respiratory sound is simply weak; later on, it becomes more and more bronchial. The bronchial breathing, which at first is due to consolidation of the alveolar structure, afterwards becomes intensified by the formation of cavities.

[1] Or tuberculo-pneumonic, in the words of Thomas Addison: Works, p. 49.

In rare eases, when the solidifieation is very dense and massive, and not yet exeavated, the respiration eeases to be audible at all.

¶ II. Diminution in the bulk of the solidified part oeeurs early in the disease, and is attended by contraetion of the eorresponding region of the ehest. When the left upper lobe is affeeted, the superfieial area of eardiae dulness will be increased. It is that form of phthisis ealled eirrhosis whieh affords the most marked degrees of shrinking of the ehest :[1] in these eases displaeement of the mediastinum and of the heart, and elevation of the diaphragm oceur.

¶ III. The fixed loealisation of mueous rales in a limited portion of lung, is an early and important sign of phthisis. At first more or less obseure in proportion to the weakening of the respiration, the rales gradually beeome elear and reverberating as the eonsolidation and uleeration proeeed.

¶ IV. The diagnosis of a eavity demands that it be near the surfaee, not smaller than a walnut,

[1] The name "cirrhosis" was first applied to the lungs by Corrigan : On cirrhosis of the lungs (Dublin Journal of Medicine, vol. xiii. 1838) : but, under other names, this callous form of phthisis has been known to physicians for centuries.

and containing for the most part air. i. Under these conditions the formation of a cavity is sometimes attended by change of the previously dull percussion sound into a clear tone. When this is the case, certain variabilities in the pitch of the tone may be noted. *a.* Wintrich discovered that the pitch varied with the openness of the mouth; the more open the mouth, the higher the pitch.[1] But this variability is not peculiar to the clear tones of cavities; it may be afforded by lung simply relaxed. *β.* Gerhardt discovered that the pitch varied with the position of the body.[2] The conditions of this sign seem to be two, namely, that the cavity be oval in shape, and that it be from a half to a third full of liquid. These things being so, if the longest diameter of the cavity be parallel with the axis of the body, the column of contained air will be shorter, and the percussion-note higher, in the sitting than in the lying posture. On the other hand, if the longest

[1] Einleitung, p. 23.

[2] Ueber Differenzen des Percussionschalles der Lunge beim Sitzen und Liegen. Deutsche Klinik for 1859. p. 108.

Die Diagnose des grössten Durchmessers der Lungencavernen. Verhandlungen der phys. med. Gesellschaft in Würzburg. Neue Folge, vol. ix. p. 1. 1875.

diameter of the cavity be transverse, from before backwards, to the axis of the body, the column of contained air will be longer, and the percussion-note lower, in the sitting than in the lying posture. Cavities which are round, or very irregular in shape, or which contain too much or too little liquid, will not yield this sign. ii. A large cavity is sometimes attended by a bulging of that part of the chest-wall which had previously been sunken. iii. The bronchial quality of the respiratory sound is always well marked in an empty cavity:[1] the rales are large and resonating. iv. The veiled puff is believed by some to be a sign of cavity. v. Practically the physical diagnosis of excavation mostly comes to this, that, in advancing phthisis, a cavity is presumed to be present where the bronchial breathing is most intense. vi. Very large cavities may afford amphoric percussion-note, amphoric hum, metallic tinkling and splashing; but never the perfect bell sound: indeed, all these amphoric signs are exceedingly

[1] The bronchial quality of the respiration and voice, and the notes of a pitchpipe, are sometimes more intense over part of the lung, than over the trachæa just above the sternum. I suspect that these signs commonly indicate a cavity in the lung.

CHAPTER XXII.

PULMONARY CANCER.

¶ I. WHAT has been said of pneumonia, tubercle, and phthisis, is true of cancer; that miliary disseminated consolidation cannot be distinguished by physical examination from simple catarrh.

¶ II. The signs of massive cancer are, in general, absolute dulness to percussion, diminished or absent vocal thrill, immobility of the chest on the affected side, and weak or absent breath-sound. When a large open bronchus is intimately connected with the cancerous mass, bronchial breathing will be heard.

¶ III. i. Cancerous solidification of the apex of one lung simulates phthisis, especially when the cancer breaks down, as it sometimes does, into cavities.[1] Physical diagnosis in such a case becomes possible only when the cancer begins to involve the mediastinum, or to spread in any

[1] J. R. Bennett: Lumleian Lectures on the natural history and diagnosis of Intrathoracic Cancer. Brit. Med. Journal. 1870, pp. 565 sqq.

other manner unlike the phthisical process. ii. Very large cancerous tumours of the lung afford signs which for the most part closely resemble those of pleurisy with effusion. But cancer, unless of most rapid growth, does not enlarge the chest, may even cause it to be retracted. The mediastinum and diaphragm are usually not displaced. Nevertheless a quickly-growing tumour sometimes tends to sprout in different directions, so as to displace the heart or depress the diaphragm. The most useful means of distinguishing between cancer and pleural effusion is drawn from the fact that the distribution of the percussion dulness differs in the two diseases. When dulness does not begin at the bottom of the chest; when there is a great extent of absolute non-resonance in front, and none behind; when, in the midst of a great extent of dulness, we detect one or more small isolated patches of resonance (haply quite clear or even cracked-pot); we may debate the existence of a solid tumour. iii. Mediastinal cancer, and pericardial or pleural effusions often concur.

uncommon in phthisis. Having ended this general survey of the signs of phthisis I will now speak of a few additional matters.

§ II. i. The chest of persons predisposed to phthisis is usually phthinoid; and that of persons actually phthisical, flat. Inasmuch as phthisis seldom involves both lungs to an equal extent, unilateral retraction of the chest is mostly present. A much more local shrinking usually occurs where the phthisical processes are most advanced. Occasionally the thorax is of emphysematous shape: this the case when phthisis is engrafted upon emphysema, or when emphysema follows retrograde phthisis. ii. Cracked-pot sound is sometimes begotten by percussion over phthisical consolidation, both when a cavity is present and when it is not. Clear trachæal resonance sometimes attends incipient phthisis, when there is no reason to suspect cavity; relaxation of the lung is probably present in such cases. iii. Sounds other than obvious rales, creaking and rubbing sounds, are not uncommon, and are most likely produced in the solidified tissues themselves; sometimes, however, undoubted transitory friction is heard. Collapse crepitation may be heard over phthisical lung. iv. The coexistence of a dif-

fused pulmonary catarrh, of emphysema, or of laryngeal disease, is a great impediment to the physical diagnosis of phthisis. Generally speaking, the physician should examine a patient, supposed to be phthisical, several times before giving a positive opinion. v. An aneurysmal dilatation of a branch of the pulmonary artery, contained in a phthisical cavity, has been known to give rise to shrill systolic murmur audible in the suprascapular fossa. Murmurs produced in the subclavian artery are not uncommon. vi. The respiration in the unaffected parts of the lungs is puerile, provided it be not modified by the presence of catarrh. The loudness of the puerile breathing sometimes leads the inexpert to predicate disease just in that solitary part where the lung remains healthy.

§ III. The difficulty of diagnosis between phthisis and some forms of pleurisy, pneumonia, and catarrh, has been already discussed. The diagnosis from pulmonary cancer and hydatid will be dwelt upon in the following chapters.

CHAPTER XXII.

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CHAPTER XXIII.

PULMONARY HYDATIDS.

HYDATID cysts, as to their physical signs, resemble, in part solid tumours of the lung, and in part liquid pleural effusions. A deep-seated cyst, even if large, cannot be detected by physical examination. When superficial, dulness to percussion, weak or absent breath sound, and temporary friction sound will be present. Large tracts of lung may be relaxed, just as in pleural effusion, and produce a resonance unnaturally clear. When the tumour becomes of very great size, all the signs of unilateral enlargement of the chest, and of displaced diaphragm and mediastinum occur. Last of all there may be a local hemispherical swelling. A cyst, which has discharged its contents into the air-passages, may, it is said, afford amphoric signs. And occasionally a hydatid tumour breaks both into the bronchi and into the pleura; when this accident occurs, all the signs of hydro-pneumothorax follow.[1]

[1] Case quoted from Mercier by Trousseau: Clinique Médicale, i. 711. 2nd edit. 1865.

CHAPTER XXIV.

DILATATION OF THE BRONCHI.

¶ I. The physical signs afforded by a sacculated bronchus are almost identical with those of a phthisical cavity. The diagnosis depends upon the symptoms. The conditions needful for the discovery of a bronchial sac by percussion and auscultation are these: that the cavity be of a certain size, near the surface, surrounded by condensed lung, and containing air as well as liquid. Rapid change in the physical signs, consequent upon profuse expectoration, is important evidence of dilated bronchus.

¶ II. Sometimes the bronchiectasis is multiple, that is to say, many tubes in one or both lungs are dilated. In this case also, the diagnosis is from phthisis; and is rendered all the more difficult by the fact that numerous cavities, separated by condensed tissue, will yield an impaired percussion note.

CHAPTER XXV.

ASYSTOLISM.

ASYSTOLISM is a useful word, employed by Beau,[1] to designate that group of symptoms which is characteristic of an enduring inability to the right ventricle to empty itself. The physical signs attendent upon asystolism are those of dilatation of the right heart. Shortly before death additional signs occur. i. Great weakening of the impulse. ii. Great weakening of the heart-sounds, and of any murmurs which may have been present, until at last nothing is heard save a kind of humming. iii. A systolic murmur, best heard at the inner part of the fourth left interspace, and due to regurgitation through the tricuspid orifice, often occurs when asystolism becomes urgent, but before the heart is so weakened as not to be able to produce a murmur.[2]

[1] Considérations générales sur les maladies du cœur. Arch. Gén. de Méd., ser. v. vol. i. Jan. Feb. 1853. Also Traité, p. 318.

[2] Parrot: Etude sur un bruit de souffle cardiaque symp-

Should the symptoms of asystolism moderate, the murmur disappears.

tomatique de l'asystolie. Arch. Gén. de Méd., series vi. vol. v. p. 385. 1865.

CHAPTER XXVI.

ENLARGEMENT OF THE HEART.

TWO lesions, seldom separated, go to make up enlargement of the heart, namely, hypertrophy of the muscular substance, and dilatation of the cavities. The proportion in which the two elements coexist differs in different cases. Although hypertrophy and dilatation are associated in fact, it is easy to dissociate them in idea, and to consider the pathology of each apart. Moreover this it is necessary to do, inasmuch as they are, in nearly every particular, antagonistic. I shall therefore treat of the signs, first of hypertrophy, and next of dilatation.

Enlargement of the heart may be simulated by pericardial effusion; by intrathoracic tumour (aneurysmal or not), above the base of the heart, or pushing the heart forwards against the front of the chest; by mere increased extent of contact between the heart and the chest-wall; by consolidation of the anterior part of either lung: and by local pleural effusion.

CHAPTER XXVII.

HYPERTROPHY OF THE HEART.

THE sign of hypertrophy of the heart is a heaving impulse, felt either at the apex-beat or over the right ventricle, that is to say, just to the left of the lower end of the sternum. Not that a heaving impulse is always present in every case of hypertrophy; feeble action of the heart, degeneration of its texture, and other conditions tend to counteract the heaving impulse; in its absence, however, there is no other certain sign of hypertrophy. The impulse, because increased in power, is increased in extent also. When the right ventricle is hypertrophied, the conducted epigastric impulse is strong. When the left ventricle is hypertrophied, the apex of the heart reaches farther to the left than natural, in consequence of the elongation of the aorta produced by the hypertrophy.

Metallic jingling, and cantering action are sometimes to be heard over the heart region. The arterial pulse is forcible and visible, except

when the aortic orifice is constricted, or when the vigour of the heart fails. A very sharp whizz is heard in the arteries by compressing them with the stethoscope; and at the same time the dilatation of the vessels may sometimes be strong enough to raise the observer's head. Hence the elongation of the aorta just alluded to: the other arteries are affected in a similar manner.

CHAPTER XXVIII.

DILATATION OF THE HEART.

THE signs of dilatation of the heart are bulging of the cardiac region, and increase in the area of cardiac dulness to percussion. The bulging has been already described. The dulness to percussion is increased in the horizontal axis of the heart; to the right when the right cavities are involved, and to the left when the left side is dilated. But the shape of the dull space is not materially changed hereby; it remains oval; a point of value in the diagnosis between an enlarged heart and a pericardial effusion. Another important diagnostic sign of dilatation is that the place of impulse moves with the extension of dulness; both sometimes reach to the left as far as the axillary line. The enlarged heart tends to displace the lungs, and so to come into contact with a larger space of the chest-wall; hence an impulse more extensive than natural.

The sounds of a dilated heart are weak. The

Fig. 19.

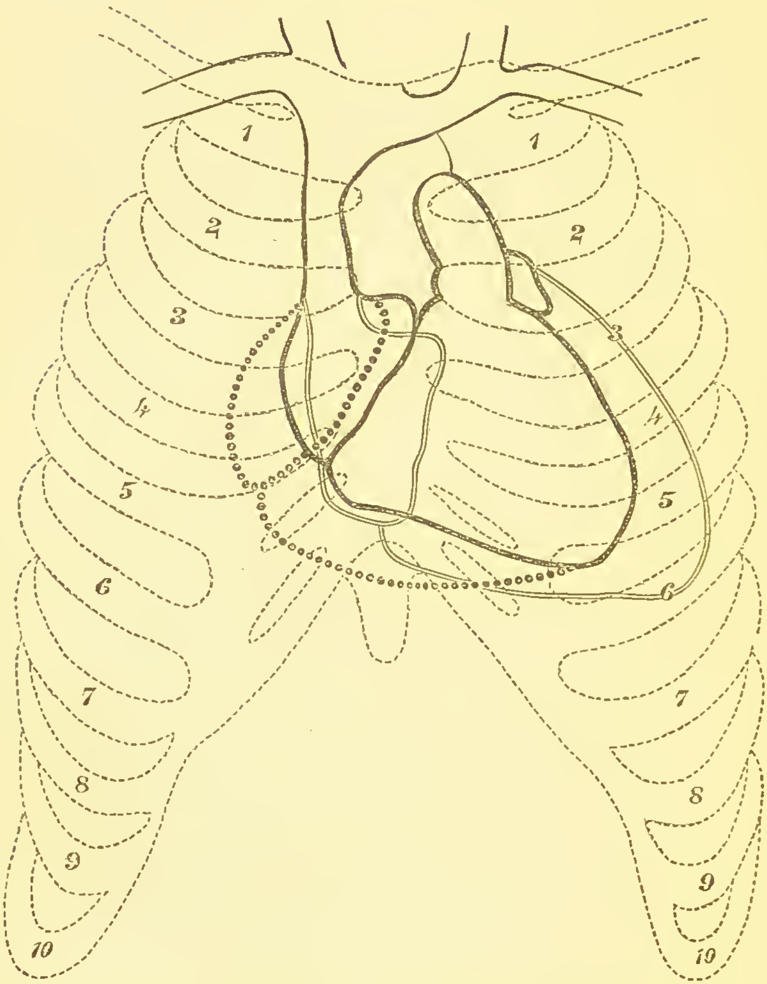

DIAGRAM SHOWING DILATATION OF THE RIGHT SIDE AND OF THE LEFT SIDE OF THE HEART: FROM VON DUSCH.

diaphragm is depressed, sometimes to such a degree that a liver of natural size may be deemed greatly enlarged. Dilatation of the right cavities tends to be accompanied by the symptoms of asystolism and obstructed venous circulation. A dilated right auricle may produce a systolic impulse in the fifth right interspace, two inches from the sternum. The diagnosis of the chronic collapse of the lower lobe of the left lung, which sometimes is caused by a dilated heart, has been discussed in the chapter upon pleural effusion.[1] It may be well to remark that the apex-beat may be displaced to the left, not only by dilatation of the left ventricle, but also by dilatation of the right heart alone, elongation of the aorta, displacement of the mediastinum to the left, and elevation of the diaphragm.

[1] T. W. King: On a morbid flattening or compression of the left bronchus, produced by dilatation of the left auricle. Guy's Hosp. Reports, vol. iii. p. 175. 1838.

CHAPTER XXIX.

PERICARDITIS.

THE physical signs of pericarditis depend upon the inflammatory effusion into the pericardium. When the quantity of the exudation is small, it cannot be discovered, unless it cause a friction-sound. For this reason, a friction-sound is usually the earliest sign afforded by pericarditis. When the quantity of the exudation is large, it is discovered by means of percussion.[1] Disappearance of a friction-sound is due either to progressing liquid effusion, or to adhesion of the inflamed surfaces. But friction is not always abolished even by a large effusion.

[1] See the next chapter.

CHAPTER XXX.

PERICARDIAL EFFUSION.

INCREASE in the area of cardiac dulness; this is the sign, not only of an enlarged heart, but also of a liquid effusion into the pericardium. The two diseases however do not extend the area of dulness in the same manner; hence the means of diagnosis between them. I have already spoken of enlargement of the heart: it remains to describe the signs of a progressive pericardial effusion.

§ I. The first extension of percussion-dulness occurs at the base of the heart, where the great vessels enter, and where the pericardium hangs loosely round them, and is most distensible. At the beginning, the dulness is increased chiefly upwards, so as to reach the second rib, in the left parasternal line. A larger effusion will cause the dulness at the base to extend transversely also, so as to reach from the right side-sternal, or parasternal, line to the left nipple line, and as high, it may be, as the first rib.

Hitherto there will have been little change in the signs afforded by that part of the pericardium which is close upon the diaphragm. However, further increase in the fluid, after it has distended the pericardial sac around the vessels, will dilate the pericardial sac around the heart. Hence, progressive increase in the transverse dulness below the base of the heart, and corresponding displacement of the lungs, until, in an extreme effusion, the non-resonant space will reach from the right nipple line to the left axillary line, and up to the top of the manubrium sterni. In which case, the area of dulness will obviously be somewhat triangular with the apex upwards. And in all pericardial effusions, whether great or small, it is the upward extension of dulness which affords the means of diagnosis from enlargement of the heart.

Gerhardt has found that, when the quantity of fluid is not very great, the dulness reaches higher in the upright than in the lying position of the body.[1] Partial pericardial adhesions, pleural adhesions, or emphysematous lung in front of the heart, will interfere with the regular development of dulness as just described.

When the effusion is limited to the base of the

[1] Lehrbuch, 1st edit., page 248.

heart, the apex-beat and the left limit of dulness will correspond; but when the cardiac portion of the pericardium is distended, the dulness will reach proportionately beyond the apex-beat, and to the left of it: this is pathognomonic. At the same time the impulse is weakened; it may finally become imperceptible; in consequence of the separation of the heart from the front of the chest. So that an impulse wholly impalpable in the lying posture may become well felt in the erect. Bulging of the heart region is consequent upon a large pericardial effusion as well as upon a dilated heart, especially in the young. In a few cases of excessive distension, a sort of undulation has been seen; comparable with pulsating empyema.

§ II. The lungs around a distended pericardium are relaxed. A large effusion sometimes exerts an amount of pressure upon the bronchi, especially of the left lung, such as to cause more or less complete collapse of the corresponding pulmonary lobe: a lesion which has been already discussed. Graves once observed a great bulging of the left lung-apex above the clavicle, dependent upon pericardial effusion.[1] The cervical veins are

[1] Clinical Lectures, 2nd edit. vol. ii. p. 176. 1848.

sometimes very full. The diaphragm is depressed, and therewith the liver and the spleen.[1] Occasionally the depression is so great as to produce a swelling of the epigastrium.[2] On the other hand, the diaphragm may be paralysed; if it be, the epigastrium sinks inwards during inspiration.

§ III. The diagnosis is from enlargement of the heart; aneurysmal, or other intrathoracic tumours; suppuration of the mediastinum; consolidation of the lung in front: and pleural effusion.

The means of distinguishing the different kinds of pericardial effusion are the following. A friction sound, occurring at any time, points to an inflammatory effusion. When gas is present in the pericardial sac, the dulness gives way to a resonant or even amphoric note: the cracked-pot sound, metallic tinkle, and succussion splash have been heard in such cases; and the heart sounds have acquired the amphoric character. But the liquid, which is always present along with the gas, yields a certain area of dulness which changes position along with change in the position of the body.

1 Senac: Traité, 2nd edit. vol. ii. p. 364. 1783.

2 Auenbrugger's Inventum Novum, § 46.

CHAPTER XXXI.

ADHERENT PERICARDIUM.

CONCRETION of the heart and pericardium does not admit of diagnosis, unless the pericardium have contracted external adhesions also with the walls of the chest in front and with the spinal column behind. Under these conditions of both internal and external past pericarditis, the following signs will be present. i. Systolic recession of the apex-beat : a sign which must be well marked to be depended upon, and which, even then, is not wholly trustworthy. ii. Deep inspiration does not diminish the area of superficial cardiac dulness : does not depress the apex-beat : and is attended by recession of the epigastrium, consequent upon the fixedness of the pericardial portion of the diaphragm. iii. Diastolic collapse of distended jugular veins.

CHAPTER XXXII.

MITRAL REGURGITATION.

A MURMUR, replacing or immediately following the first sound, and heard louder at or just above the apex-beat than over any other part of the heart region, indicates regurgitation through the mitral orifice. The murmur is usually conducted to the angle of the left scapula: is sometimes much louder at the angle of the scapula than at the apex-beat: is sometimes indeed heard at the angle of the scapula only, and not at all at the apex-beat.[1] Incompetence of the mitral cusps is not always attended by a murmur: this is especially the case in asystolism. On the other hand it is still open to de-

[1] According to Naunyn, a mitral regurgitant murmur is sometimes heard loudest over the pulmonary artery, in consequence of the position of the left auricle, so close to the root of that vessel: the murmur produced at the mitral orifice passing backwards into the auricle. Berlin klin. Wochenschr. 1868, No. 17. Ueber den Grund, wesshalb hin und wieder das systolische Geräusch bei der Mitralis-insufficienz am lautesten in der Gegend der Pulmonalklappen zu vernehmen ist.

bate whether systolic murmurs at the apex do not sometimes, or even often, occur apart from regurgitation through the mitral orifice.

Congestion of the lungs, its consequences and the appropriate signs, are common in mitral regurgitation.

CHAPTER XXXIII.

MITRAL OBSTRUCTION.

A MURMUR, after the second sound and before the first, heard louder at the apex-beat than over any other part of the heart region, indicates obstruction at the mitral orifice.[1] i. The murmur is usually præsystolic, that is to say, it is immediately followed, without any interval, by the first sound. The murmur is sometimes undoubtedly diastolic, that is to say, it immediately follows the second sound; there being a distinct interval between the murmur and the first sound.. ii. The murmur, whether præsystolic or diastolic, is seldom heard at the angle of the scapula. iii. The influence of posture upon præsystolic murmurs has been already discussed. iv. A præsystolic murmur sometimes passes indistinguishably into a systolic

[1] The connection between præsystolic murmurs and mitral obstruction was discovered by Fauvel: Mémoire sur les signes stéthoscopiques du rétrécissement de l'orifice auriculo-ventriculaire gauche du cœur. Archives gén. de Méd., series iv. vol. i. p. 1. 1843.

murmur: but usually a loud first sound is heard, and no systolic murmur. A diastolic murmur is attended, so far as I know, by a systolic murmur. v. The second sound is usually inaudible at the apex-beat.

A thrill often attends the murmur: either præsystolic and running up into the impulse; or diastolic and alternating with the impulse, pendulum-wise.

A moderate degree of mitral constriction will afford the signs of regurgitation only, namely, a systolic murmur, and no thrill.

Overfilling of the left auricle and pulmonary congestion are carried to a high degree. Hence accentuation of the pulmonary second sound, and hypertrophy with dilatation of the right heart. But dilatation of the tricuspid orifice and tension within the pulmonary artery are antagonistic, as the former progresses the latter diminishes, wherefore the loudness of the pulmonary second sound becomes gradually less. In like manner, the aortic second sound is enfeebled and finally disappears, on account of the small quantity of blood sent out into the aorta.

CHAPTER XXXIV.

AORTIC REGURGITATION.

A MURMUR, replacing or immediately following the second sound, and heard loudest at the second right interspace and along the sternum, indicates regurgitation through the aortic valve.[1] i. The second sound is sometimes well heard at the second right interspace: even when this is not the case, the second sound is usually heard at the second left interspace. ii. The murmur is often heard better at the bottom of the sternum than at the base of the heart. iii.

[1] Incompetency of the aortic valves was known to morbid anatomists long before the discovery of auscultation. Hodgkin seems to have been the first to discuss the lesion from the clinical point of view. His papers, "On retroversion of the valves of the aorta," were read before the Hunterian Society on February 21st, 1827, and February 18th, 1829, and were published in the Lond. Med. Gazette for March 7th, 1829. See Wilks: Note on the history of valvular diseases of the heart: Guy's Hosp. Reports, series iii. vol. xvi. p. 209. 1871. Hodgkin mentions the diastolic murmur, which Corrigan, in his paper, published in 1832, does not.

The murmur is often, but certainly not always, conducted to the apex. iv. The murmur is often conducted into the arteries near the heart, the carotids and subclavians, so as to be well heard below both clavicles: but this is not always so. v. In a few cases, the murmur possesses a loud whining or cooing character. A murmur of this kind may be audible in all the larger arteries, even so far away as the radials; all over the front of the chest; in the left axilla, and at the angle of the left scapula; by the ear placed nigh to, but not upon, the chest; and lastly, by the patient himself. vi. The murmur is sometimes best heard over the second left interspace or third left cartilage. This means that the heart is displaced to the left; most likely in consequence of elongation of the aorta; the apex-beat will be found to the left of the nipple line. The diagnosis of such cases depends much upon the characters of the pulse. vii. A systolic basic murmur also is commonly present: or at any rate the first sound is not clear. This murmur is certainly not always due to obstruction at the mouth of the aorta, but is probably sometimes the result of a mere relative constriction of the orifice, connected with positive dilatation of the ascending aorta.

A diastolic thrill, at the second right interspace, is sometimes present. In the displacement of the heart to the left just spoken of, the thrill may be felt in the second or third left interspace.

Just as mitral diseases tend to be followed by pulmonary congestion and enlargement of the right heart, so do aortic diseases bring after them hypertrophy of the left ventricle. Hence the heaving impulse mostly, but not always present. Hence the frequency of dilatation of the ascending aorta: hence the elongation of the arteries, and the visibility of the pulse: hence the hardness of the pulse,[1] and the intensity of the arterial systolic murmur: hence the phænomenon of a capillary pulse, observed by Lebert, that is to say, a systolic flushing of the face. Hence, lastly, the peculiar cardiographic sign which has been described by Marey,[2] and

[1] "Après avoir remarqué l'abattement de ses yeux, la bouffissure, et la pâleur de son visage, j'examinai son pouls qui me parut fort plein, fort vîte, dur, inégal, et si fort que l'artère de l'un et l'autre bras frappait le bout de mes doigts autant que l'auroit fait une corde fort tendue et violemment ébranlée." Histoire de Jean Chifort (case of disease of aortic sigmoids): Vieussens. Œuvres françoises, 1715.

[2] Notes sur un nouveau signe de l'insuffisance aortique. Gaz. Méd. de Paris, 1868, No. 38.

which consists in a too rapid ascent of the traced line between the second sound and the auricular systole, indicative of a too rapid filling of the ventricle. Duroziez' diastolic arterial murmur sometimes becomes a valuable sign of aortic regurgitation. Yet the heaving impulse, and all the arterial signs are sometimes not present, even when a distinct diastolic murmur in the aortic region renders the nature of the disease quite certain.[1]

Mitral disease, indicated by its appropriate signs, often concurs with aortic regurgitation, and tends somewhat to counteract its signs.

The diastolic murmur, the signs of hypertrophy of the ventricle, and the peculiar water-hammer pulse, are the most important signs of aortic regurgitation. But numerous cases have been observed[2] of an aortic diastolic murmur

[1] Stoll has noted the coincidence of aortic regurgitation and sudden death. In the sixteenth post-mortem examination described in Ratio Medendi, vol. i., Vienna, 1777, the aortic sigmoids were found so much diseased as to be quite incapable of closing the valvular orifice : "Mortem repentinam ab aucto humorum ad cor allapsu deduximus, qui ab osseo aortæ capite, valvulisque ferme ex toto rigidis expediri promoverique ulterius nequiverant."

[2] By Cruveilhier, Vulpian, Gubler, Fournier : see Edinb. Med. Journ. vi. page 471. See also Marey : the paper just cited.

heard during life, not to be explained by any lesion of the aortic valve found after death. In all these cases, however, the aorta has been unnaturally rigid, if not dilated. Wherefore it seems that a murmur, in all respects like that of aortic regurgitation, may be produced immediately above the valves. Marey declares that the cardiograph affords the only means of diagnosis, the sign above described being peculiar to aortic regurgitation.

CHAPTER XXXV.

AORTIC OBSTRUCTION.

THE murmur present in eases of aortie obstruction is systolie, and heard loudest in the seeond right interspaee. But many inorganie murmurs possess these eharaeters. Wherefore it is not allowable to diagnose an obstruetion unless the murmur be loud and long, and attended by a heaving impulse eharaeteristie of hypertrophy of the left ventriele, and by a pulse whieh is small even when the heart is beating strongly: moreover the signs of aneurysm must be absent. A systolie thrill, felt on the right side of the base of the heart, is often present. Aortie obstruetion is usually eomplieated with regurgitation; even when there is no diastolie murmur, the aortie seeond sound is muffled, weakened, or absent. The pulmonary seeond sound is unaffeeted, inasmueh as the mitral valve bears off the retrograde development of disease.

The physieal eonditions of inorganie aortie

systolic murmurs have been already discussed under the head of vascular murmurs of the heart region. It is in states of debility, or during fits of palpitations, that inorganic systolic aortic murmurs are heard. They are always soft; and cease with the debility or the palpitations, as the case may be.

CHAPTER XXXVI.

TRICUSPID REGURGITATION.

TRICUSPID regurgitation, in the great majority of eases, is merely a part of dilatation of the right side of the heart, and secondary to impeded eireulation through the lungs. The attendent murmur is systolic, and heard best over the lower part of the sternum. But eommonly it is only when the distension of the orifiee is extreme that the murmur beeomes audible: for whieh reason, it is most frequently heard when the heart falls into a state of asystolism: henee, moreover, the murmur is often temporary. The important signs of trieuspid regurgitation, whieh the jugular veins afford, have been already deseribed. Weakness of the pulmonary seeond sound has been notieed onee or twiee, but the ordinary eause of tricuspid regurgitation (namely the obstructed pulmonary eireulation) interferes with the oeeurrenee of this sign. A systolic thrill at the epigastrium is said to have been present in a few eases. Passive dilatation of the right heart is a eonstant aceompaniment.

Mitral regurgitant murmurs may somtimes be mistaken for tricuspid: the diagnosis, in a difficult case depends chiefly upon the fact that obstruction is often associated with regurgitation at the mitral orifice, but very seldom at the tricuspid. So that if a murmur be at all præsystolic it is probably mitral. Moreover a tricuspid murmur is usually very soft in character.

Parrot has sought to show that the so-called anæmic murmurs, which have been commonly regarded as produced in the pulmonary artery or in the aorta, are really due to tricuspid regurgitation, consequent upon relaxation of the heart's tissues.[1] He maintains that these murmurs are heard loudest at the left side of the sternum, in the fourth interspace (somtimes third or fifth) and that they are inaudible higher up. Certainly this is the seat of tricuspid murmurs, but I cannot agree that it is the ordinary seat of anæmic murmurs. However, it is not only possible but probable that a tricuspid regurgitation, like a mitral regurgitation, may sometimes be the result of great debility.

[1] Etude clinique sur le siége et le mécanisme des murmures cardiaques dits anémiques. Arch. Gén. de Méd. series vi. vol. viii. p. 129. 1866.

CHAPTER XXXVII.

TRICUSPID OBSTRUCTION.

THIS is an uncommon disease. The murmur is diastolic, and heard loudest about the bottom of the sternum. In a few cases the murmur has been distinctly præsystolic, and accompanied by a præsystolic thrill.[1] The systemic venous circulation is obstructed. On the other hand, in simple tricuspid constriction, the tension within the pulmonary vessels would be reduced, and thereby the pulmonary second sound be weakened, were it not that mitral disease usually complicates the tricuspid.

[1] Gairdner and Haldane: papers before quoted. Hayden: Coincident mitral and tricuspid stenosis: Dublin Journal Med. Sc., May, 1874. Duroziez declares that tricuspid obstruction is accompanied by a systolic murmur: Du rétrécissement de la tricuspide: Gazette des Hôpitaux: Nos. 78 and 79. 1868.

CHAPTER XXXVIII.

PULMONARY REGURGITATION.

THIS, the rarest of all valvular diseases, is attended by a diastolic murmur, heard loudest in the second left interspace and along the sternum. The pulmonary second sound disappears, or is greatly altered. A diastolic thrill is sometimes present. A systolic murmur, not due to obstruction, occurs in pulmonary regurgitation like as in the corresponding aortic disease. Both murmurs are sometimes loud enough to be heard all over the heart region, and yet are not heard to the right of the sternum over the second interspace. Hypertrophy of the right ventricle, and impeded systemic venous circulation, with dilatation and pulsation of the jugulars, are secondary consequences.

CHAPTER XXXIX.

PULMONARY OBSTRUCTION.

THE murmur of pulmonary obstruction is systolic, and heard loudest on the third rib, or in the second or third left interspace, close to the sternum.[1] A systolic thrill may sometimes be felt at the same spot. A loud murmur may be conducted far in all directions. Hypertrophy of the right ventricle supervenes; so that it is not until the obstruction becomes great, or the heart's contractions begin to fail in vigour, that there is any stagnation in the general venous system.

Inorganic murmurs frequently assume the time and place indicative of pulmonary obstruction. Sometimes they can be explained by the pressure of solidified lung (phthisical or pneumonic) upon the artery: sometimes pressure

[1] Ormerod: On a systolic murmur in the pulmonary artery. Edin. Med. and Surg. Journ., No. 166, 1846. Meynet: Rétrécissement de l'orifice de l'artère pulmonaire, consécutif à une endocardite valvulaire. Gaz. Méd de Lyon. 1867: No. 38, p. 538.

by the stethoscope produces the murmur, especially in patients with a phthinoid chest: but often enough the murmur cannot be thus explained. When this is the case we may suppose a relative dilatation of the pulmonary artery, as was formerly explained. It is especially in states of debility and impoverished blood that pulmonary inorganic murmurs occur.

CHAPTER XL.

MALFORMATIONS OF THE HEART.

CONGENITAL malformation of the heart is usually discovered easily enough; but not so the precise kind of malformation. We may attempt a diagnosis for which our data are mostly insufficient, but we shall seldom advance beyond a guess.

i. The heart region is sometimes bulged, especially in older patients. ii. The impulse is often heaving, often diffused, sometimes hardly palpable. iii. The apex-beat is commonly displaced to the left, and is also lower than natural. iv. Extension of percussion dulness to the right is not uncommon. v. A murmur, systolic, and heard loudest over the pulmonary region (from the second to the third left interspace, close to the sternum), is common: the murmur is very local, or heard over the heart region, or conducted more or less extensively over the chest. Much less common murmurs are these: diastolic in pulmonary region, with or without systolic:

systolic at left apex: systolic at epigastrium, or just above and to the left thereof: and probably others which I have not met with. Sometimes the murmur disappears just before death. Sometimes there is no murmur at all. vi. A thrill often, not always, coincides with the murmur; being best felt where and when the murmur is loudest; and being very local or conducted more or less widely. vii. Signs in the jugular veins are uncommon.

CHAPTER XLI.

INFLAMMATION OF THE MEDIASTINUM.

THERE are different kinds of inflammation of the mediastinum: to wit:

¶ I. Acute dropsy of the mediastinum. i. Spontaneous serous fluxion upon the mediastinum is a very uncommon disease. Hamburger has narrated a case which probably was of this kind.[1] In this patient the posterior mediastinum chiefly was affected. There were present all the symptoms of acute obstruction to the vena cava superior. The heart was pushed forward, and beat strongly against the chest wall. The percussion signs were natural. When the patient swallowed some water, and, at the same time, the ear was applied to his back on the left side of the third dorsal vertebra and below; instead of a clear clucking sound, a weak obscure murmur was

[1] Auscultation des Œsophagus als diagnostischer Behelf in Mediastinal-krankheiten. Vierteljahrschrift: vol. i. p. 112. Prag., 1870. Hamburger refers to a case described by Rayer.

heard; probably indicative of enfeebled œsophageal contraction, and also of bad conduction of the sound which was produced. ii. Hydromediastinum is usually associated with hydrothorax or hydropericardium as part of general dropsy.

¶ II. Adhesive inflammation of the mediastinum is chronic, and secondary to pleurisy (especially empyema) or to severe pericarditis. The only signs are those which are dependent upon the fixity of the heart, and these have been already described under the head of Adherent Pericardium.

¶ III. Suppurative mediastinitis also is usually a chronic disease. i. A collection of pus in the anterior mediastinum causes a corresponding extent of percussion-dulness. Even when the pus comes to the surface the diagnosis is not always easy, for the abscess may appear in the situation of an aneurysmal tumour, and may even pulsate. Signs of purulent pleurisy or pericarditis sometimes concur. ii. The diagnosis of posterior mediastinitis is not much helped by physical examination. Auscultation of the œsophagus might prove serviceable, but has not been, so far as I know, actually practised.

CHAPTER XLII.

MEDIASTINAL TUMOURS:

INCLUDING tumours developed in the connective tissue, and enlargement of the thymus, or of the bronchial glands. i. A large and quickly-growing tumour sometimes causes protuberance of the front of the chest in the neighbourhood of the sternum: and this protuberance may pulsate with the pulsations of the aorta. ii. The heart may be displaced downwards, upwards, or to either side; or may be pressed forwards. iii. Dulness to percussion will exist over a tumour which is in contact with the chest-wall, either in front, behind, and alongside the sternum; or behind, displacing one or other lung: except that small tumours, connected with the trachæa or a bronchus, will afford a clear, trachæal note. iv. The tumour, when small, conducts sounds generated in its vicinity or not; bronchial breathing, bronchophony, and the heart's sounds: when large, there is no sound to be heard over the tumour.

v. Sometimes a systolic murmur at the base of the heart is produced by the pressure of the tumour, and so an aneurysm may be simulated. vi. The signs of obstruction to the large veins are common. vii. The œsophagus should be auscultted when disease in the posterior mediastinum is suspected. viii. Signs of obstruction to one bronchus; of collapse of the lung; of destructive or gangrenous pneumonia; of pleurisy with effusion; and of pericarditis; may be expected. ix. With regard to disease of the thoracic lymphatic glands, I would say that there are no physical signs of scrofulous (tuberculous) disease of the bronchial glands (strictly so-called, namely, those in the roots of the lungs and the bifurcation of the trachæa): whereas, disease of the trachæal glands often affords dulness to percussion alongside the sternum, and sometimes a swelling to be felt deep in the neck, behind the clavicle.

CHAPTER XLIII.

ANEURYSM OF THE THORACIC AORTA.

§ I. ANEURYSMS of the thoracic aorta must attain a size sufficient to bring them into contact with the chest-wall before they yield any physical signs directly dependent upon the aneurysm itself. Earliest to appear are the signs afforded by palpation and percussion.[1]

¶ I. By Palpation are detected pulsations and thrills. The Pulsation is systolic, synchronous with the latter part of the impulse of the heart. A slight diastolic shock, due to closure of the aortic sigmoids, is sometimes perceptible over an aneurysmal tumour: in a case seen by Walshe there was a strong diastolic

[1] Aneurysm of a Valsalvian sinus seldom affords distinctive physical signs. Pulsating tumour is present in about seven per cent. of the cases, one half being to the right, and one half to the left of the sternum. Murmur is common, and due to regurgitation through the aortic or pulmonary valves. Sibson: The aorta and the aneurisms of the aorta: reprinted from "Medical Anatomy, fasciculus v." 1858; p. 2.

impulse.[1] When the aneurysm contains much coagulum, the pulsation is weak or even absent. i. Aneurysm of the ascending aorta touches the chest-wall first in the second right interspace close to the sternum : along with increase in the size of the tumour, the pulsations become felt upwards towards the clavicle and manubrium sterni, or downwards along the right margin of the sternum, haply as low as the fourth, or even fifth, interspace. ii. Aneurysm of the transverse aorta first comes to the surface behind the upper part of the sternum, and afterwards extends far away towards the left. iii. Aneurysm of the descending aorta, at its upper part, points below the first left rib, and thence extends downwards to the second space. iv. Aneurysm of the lower part of the thoracic aorta lies upon the left side of the dorsal vertebræ and may cause pulsation there. The site of pulsation sometimes is also the site of systolic or diastolic Thrill.

¶ II. By Percussion, dulness may be discoverable in the same situations: namely, in the neighbourhood of the second and third ribs along the right side of the sternum ; behind the

[1] A Practical Treatise on the Diseases of the Heart and Great Vessels. 3rd edit. 1862, page 457.

manubrium sterni; to the left side of the sternum; and along the left side of the dorsal vertebræ. The aneurysmal dulness is sometimes conterminous with the cardiac dulness, sometimes not.

¶ III. By Inspection, a tumour upon the surface of the chest is sometimes detected. The position of the tumour corresponds with that of the palpation and percussion signs. The shape of the tumour is hemispherical, except that it is sometimes nodular when it is constricted by resistent fibres in the overlying parts, or when the aneurysm itself is nodular. An aneurysmal tumour of the descending aorta may be of a size so great as to push the scapula outwards.

¶ IV. By Auscultation there will be discovered a first and second sound, or a systolic and diastolic murmur, or a first sound and diastolic murmur, or a systolic murmur and a second sound, or no kind of sound at all. The sounds are probably those of the heart conducted: the systolic murmur is due to the passage of blood through a relatively narrow mouth into a wider cavity, whether an aneurysmal sac or a dilated aorta: the diastolic

murmur is either a conducted murmur produced at the mouth of the aorta, or is due to the passage of blood out of a sac, or is inexplicable. The murmurs, when loud, may be conducted far away.

§ II. Uniform dilatation of the ascending aorta is attended by extension of percussion dulness to the right of the margin of the sternum, on the level of the second and third cartilages, and behind the manubrium sterni. Elongation of the arch of the aorta forces the base of the heart downwards and to the left; in which case the apex-beat comes to be lower and more external than natural.

§ III. An aneurysmal tumour, like other mediastinal tumours, will compress neighbouring viscera. i. Pressure upon the trachea causes a peculiar harsh and noisy breathing, audible at a distance from the patient. ii. Pressure upon the bronchus, commonly the right, causes the same symptom; by auscultation, the sound will be loudest where the second rib joins the sternum. iii. Pressure upon the spongy structure of the lung produces relaxation or collapse of the part involved: pressure upon the root of the lung tends to produce destructive and gangrenous pneumonia. iv. Pressure upon the œsophagus

probably produces signs like those which were present in Hamburger's case of mediastinitis. v. Pressure upon the vena cava superior or vena innominata is attended by the appropriate signs of venous obstruction. vi. The heart is liable to sundry displacements, thus: dilatation of the ascending aorta usually implies elongation thereof, whereby the heart is forced downwards and to the left: a large tumour of the transverse aorta produces the same effect: a very large tumour of the descending aorta will push the heart towards the right: a tumour behind the heart will press it against the front wall of the chest.

§ IV. Anastomotic aortic aneurysms; that is to say, those which open into a neighbouring part of the circulating system. i. Into the vena cava superior: the signs are those of aortic aneurysm and venous obstruction, together with a strong systolic thrill and murmur in the veins of the neck, and haply a thrill and loud systolic murmur at the second right cartilage. ii. Into the right auricle: no signs more definite than those of an aortic aneurysm and of venous obstruction. iii. Into the right ventricle: no definite signs. iv. Into the pulmonary artery: the case narrated by Wade, in a paper already quoted, yielded these signs: systolic and long

diastolic murmur at fourth left rib; no natural sounds there; diastolic thrill at the same spot; diastolic murmur inaudible at the apex-beat; pulsation and thrill in the carotids.

CHAPTER XLIV.

OTHER INTRATHORACIC ANEURYSMS.[1]

§ I.—ANEURYSM OF THE INNOMINATE ARTERY.

¶ I. Dilatation of the part of the artery nearest to the heart is always associated with aneurysm of the ascending aorta, and is not attended by any distinctive signs.

¶ II. Dilatation of the distal part of the artery affords these signs following: i. A pulsating tumour, which comes up, between the origins of the sterno-mastoid muscle, from behind the right sterno-clavicular articulation, is due to an innominate aneurysm; provided there be no signs of aortic disease. For aortic aneurysm may rise into the same position. The head of the clavicle may be dislocated. ii. If there be, over the tumour, a systolic murmur, it is conducted into the right carotid, but not into the left. iii. Pressure upon one or both of the innominate veins is common.[1]

[1] Cockle: Contributions to the Pathology of Aneurisms and Tumours, involving the upper portion of the Chest and Root of the Neck. Medico-chir. Trans., vol. 50, p. 459. 1867.

§ II.—ANEURYSM OF THE PULMONARY ARTERY.

A very uncommon disease, seldom discoverable during life. Yet these signs are said to have been noted: i. More or less swelling about the second and third left interspaces, nigh the sternum. ii. Systolic, and sometimes diastolic, impulse there. iii. Some dulness to percussion. iv. Very loud sounds or murmurs, especially systolic, in the same place. v. Consecutive lesions relate to the right, rather than to the left, heart.

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THE END.

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